Illuminating Engineer

XXVII. November, 1934 Price 9

THE JOURNAL OF GOOD LIGHTING

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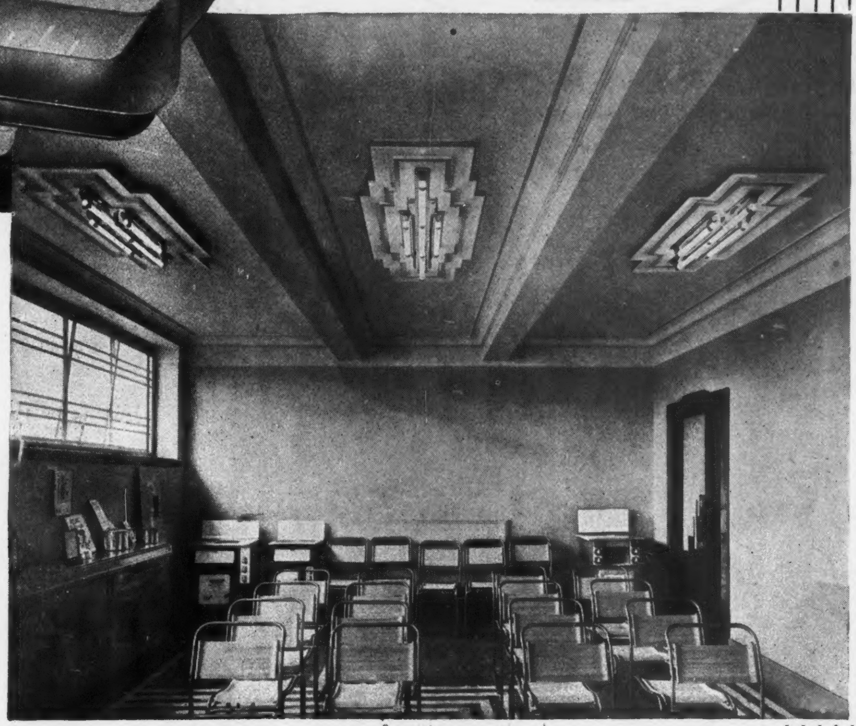

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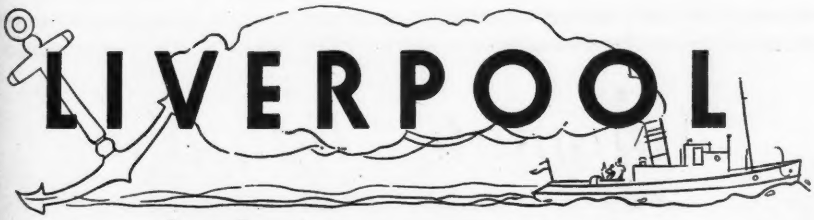

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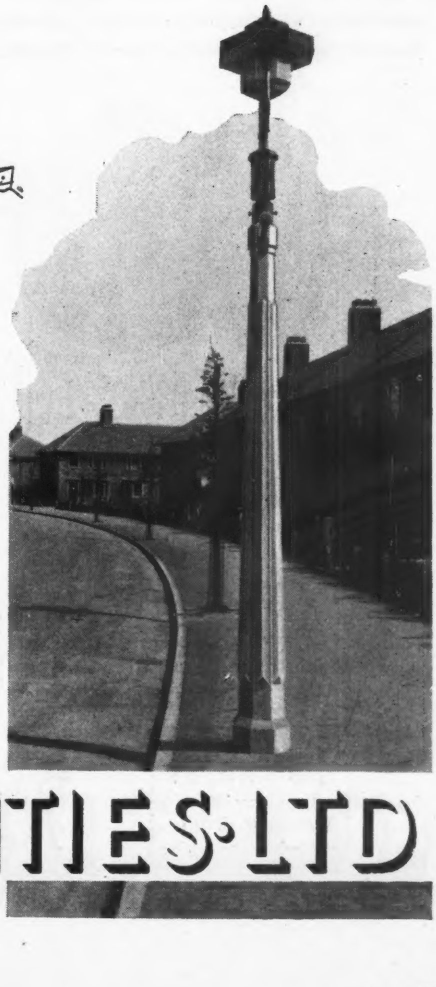

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Official Journal of THE ILLUMINATING ENGINEERING SOCIETY
FOUNDED IN LONDON 1909
INCORPORATED 1930

The ILLUMINATING ENGINEER

THE JOURNAL OF GOOD LIGHTING

Edited by

J. STEWART DOW

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Light Ahead!

THE Illuminating Engineering Society, having just passed the half-way mark towards its Jubilee, has started the next lap in promising style.

The Opening Meeting in London on October 9th, and the Supplementary Meetings arranged in Birmingham (October 11th) and Liverpool (October 16th), were very successful, and may be repeated at other centres. The items on the programme at these opening meetings become more numerous every year. Already the show is ceasing to be a demonstration and becoming an Exhibition.

The Presidential Address revealed a stirring of new ideas, which were sympathetically received. We hope that these ideas, which have for their object the broadening of the basis of the illuminating engineering movement in this country, will be explored and developed.

During recent years, as the President truly said, "Much has been done." The Society has established its position on a firm basis. But the movement cannot stand still. The time is ripe for an advance on a wide front. ***Light Ahead!***

Progress in Industrial Lighting.

The announcement of the forthcoming paper on industrial lighting by Mr. R. W. Daniel, to be read before the Illuminating Engineering Society on November 13 reminds us that an interesting reference to this subject occurs in the report of the H.M. Chief Inspector of Factories for the past year. The revelation of the unsatisfactory conditions in Sheffield, recently reported by Mr. Daniel*, has led to a substantial improvement. Of 475 factories then visited only 27 possessed up-to-date lighting. As a result of recommendations made, improved conditions, wholly or partly completed, have since been reported in 128 factories—certainly a good example of what good advice, backed up by demonstrations with a direct-reading photometer, can accomplish. In the South of England the lighting exhibit at the Home Office Industrial Museum, supplemented by lectures in many parts of the country, has also led to considerable improvement.

Various devices adopted in special cases are mentioned. In a large steel works light is now directed the full length of a long permanent way, out of which various doorways open, and at the far end impinges on a photo-electric cell. An approaching engine or vehicle cuts off the beam, and, by the action of a relay, causes red danger signals to glow at all doorways opening on the track—a device which should do much to avoid danger and accidents. Improvements in the lighting of inspection pits of garages by means of reflection-lights fitted along each side of the pit, the mounting of lamps on the underside of overhead cranes, the use of special devices to avoid glare during the inspection of bottles for cleanliness, and the use of photo-electric cells to switch on artificial light (in two stages) as daylight fails are also noted. The new electric discharge lamps are stated to be proving acceptable for a number of processes where good diffusion is important, and in some cases the colour of the light is apparently a positive advantage—for instance, in the examination of silvered plate glass.

* Illum. Eng., September, 1933, p. 207.

Internally-Illuminated Yellow Diffusing Globes For Traffic Control Signals.

A British Standard Specification has recently been issued for Internally-Illuminated Yellow Diffusing Globes for Traffic Control Signals (B.S.S. No. 566-1934). The specification, which was prepared at the request of the Ministry of Transport, deals with the material of the globe, its dimensions and thickness. It gives limits for colour, together with a test for ascertaining that the globe conforms to these limits. It requires that the filament shall not be visible when viewed in any direction from which the globe is normally viewed, and lays down a test for the mean horizontal candle-power ratio of the globe, a figure for which is specified. Copies of this specification (No. 566-1934) can be obtained from the British Standards Institution, 28, Victoria-street, London, S.W.1 (price 2s. 2d. post free).

The "Stop" Light.

Lights are now being so widely and variously used to convey messages that the "language of signs" is becoming chaotic. The motorist formerly assumed, as an invariable rule, that red lights should be passed on the right, white lights on the left. But there are now so many red lights besides the tail lights of vehicles—traffic signals, lights attached to street obstructions, flashing beacons, and advertising signs—that this rule no longer applies with certainty. A particularly awkward device, mentioned by *Municipal Engineering,* is the single red lamp sometimes placed on crossing gates, on the offside! Our contemporary rightly points out the need for some distinctive device to imply "Stop!" and *nothing else.* A red light, if it has traditional meaning, implies "danger," which is not necessarily the same as "stop!" and, as shown above, it may also suggest other things.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

The Illuminating Engineering Society

Opening Meeting of the Session

(Held at the E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C., at 6 p.m. on Tuesday, October 9th, 1934).

THE opening meeting of the Illuminating Engineering Society took place at the E.L.M.A. Lighting Service Bureau (2, Savoy Hill, London, W.C.) on Tuesday, October 9, when there was an excellent attendance. In view of the exceptional length of the programme, members and friends assembled for light refreshments at 6 p.m. (half an hour earlier than usual), and the chair was taken by Mr. C. W. Sully at 6.30 p.m. The minutes of the last meeting having been taken as read, the Hon. Secretary then read out the names of applicants for membership (see p. 332). The names of those announced at the last meeting of the Society* were read again, and these gentlemen were formally declared members of the Society.

Introduction of New President.

Mr. C. W. Sully then said that he had very much pleasure in introducing the new President (Mr. H. Hepworth Thompson), who thereupon took the chair.

The President, in assuming the chair, assured those present that he would do his best to fill the office as ably as his predecessor had done. Mr. Sully had presided at meetings with distinction, and with never-failing courtesy and charm. He had been most enthusiastic in his efforts on behalf of the Society, notably in connection with the arrangement of provincial meetings, to which he had devoted much time and trouble (Applause).

Award of Leon Gaster Memorial Premium.

The President then said that the first duty that fell to him was a very pleasant one—to announce the decision of the Council to award the Leon Gaster Memorial Premium to Mr. A. W. Beuttell for his excellent paper, entitled "An Analytical Basis for a Lighting Code," read at the meeting of the Society on December 12, 1933.

Mr. A. W. Beuttell expressed his great appreciation of this award, which he regarded as a great honour. There was just one thing he would like to recall, the help he had received from Mr. W. J. Jones and the sub-committee concerned with the examination of this problem, which had proved most valuable.

* ILLUMINATING ENGINEER, May, 1934, p. 179.

Annual Report of Progress.

The Hon. Secretary then briefly presented the Annual Report of Progress, prepared by the Technical Committee. He pointed out that this was quite as comprehensive as in previous years, and contained many interesting instances of progress, and he expressed the thanks of the Council to all those who had helped in its preparation.

Forthcoming Events.

November 13th. Mr. R. W. DANIEL on **Industrial Lighting: Some Problems in Sheffield and their Solution;** *(Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W.1)*; **6.30 p.m.**

December 3rd. Mr. C. W. SULLY on **The Outstanding Characteristics of Illumination by Electricity;** *(Joint Meeting with the Electrical Association for Women, 20, Regent Street, London, S.W.1)*; **7 p.m.**

December 11th. Mr. H. E. BLOOR on **Floodlighting with Gas;** *(Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W.1)*; **6.30 p.m.**

Presidential Address.

The President then delivered his address (see pp. 333-335), in which a number of suggestions relating to the future of the Society and the movement with which it is concerned were made. In response to his invitation to members to comment on these proposals, brief remarks were made by Mr. J. S. Dow, Mr. C. W. Sully, Mr. A. W. Beuttell, Mr. A. Cunnington, Mr. J. Eck, Mr. H. H. Long, Mr. R. O. Ackerley, and Col. C. H. Silvester Evans, all of whom expressed their interest in these ideas, which deserved most careful consideration by the Council and members.

Applicants for Membership.

SUSTAINING MEMBER:—

The Sun Electrical Co., Ltd., 118-120, Charing Cross Road, London, W.C.2.

Representative:—Mr. J. Harris.

CORPORATE MEMBERS:—

Bennett, C. Valon...Rochester, Chatham & Gillingham Gas Co., 95, High Street, ROCHESTER.

Blondin, J. C. ......Gas Light & Coke Co., 233,237, High Street, ACTON.

Brown, E. J. W. ...Metropolitan Borough of Stoke Newington, Electricity Office, Edwards Lane, Church Street, LONDON, N.16.

Cooper, H. C. ......Mek-Elek Engineering, Ltd., 16, Douglas Street, LONDON, S.W.1.

Diamond, J. B. ...Folkestone Gas Company, Folkestone, KENT.

Field, H. S. ....Ascog, Ltd., 44, Theobalds Road, LONDON, W.C.1.

Gamble, B. T. ......5, Holland Road, Wembley, MIDDLESEX.

Harmer, E. W.......Edison Swan Electric Co., Ltd., 155, Charing Cross Road, LONDON, W.C.2.

Langford, L. J. ...Tunbridge Wells Gas Company, 44, High Street, Tunbridge Wells, KENT.

Leslie, C. W. ......Stafford & Leslie, Armour House, St. Martins-le-Grand, LONDON, E.C.1.

Mitchell, J. ....Southgate & District Gas Company, Station Road, New Southgate, LONDON, N.11.

Rogers, R J ......Parkinson Stove Co., Stechford, BIRMINGHAM.

Scrivener, S. W....London Electric Firm, Brighton Road, SOUTH CROYDON.

Tate, G................48, Waverley Road, St. Albans, HERTS.

COUNTRY MEMBERS:—

Baker, R. H. ......Wayland Works, Minworth, BIRMINGHAM.

Ball, F. A. ....Messrs. Ball Bros., Reliance Works, STRATFORD-ON-AVON.

Belton, C. M. D....Gas Works, Castle Foregate, SHREWSBURY.

Bloor, H. F .....The York Gas Company, Davygate, YORK.

Davies, D. Herne Bay Gas Company, Beach House, Beach Street, Herne Bay, KENT.

Glover, W. S. ......T. H. Satchell, Ltd., Bridgeman Street, WALSALL.

Heaps, E. ....Brighton Lighting & Electrical Engineering Co., Ltd., St. Martin's Place, Lewes Road, BRIGHTON.

Helps, G. ....Nuneaton Gas Works, Nuneaton, WARWICKSHIRE.

Hornby, J. H. ......Maidstone Gas Company, "Bella Vista," Buckland Road, Maidstone, KENT.

Morris, A. L. ......Cheltenham & District Gas Co., Central Office, CHELTENHAM.

Silva, S. R. de......Electricity Department, U. D. C., Moratuwa, CEYLON.

Taylor, J. ....32, The Boulevard, WESTON-SUPER-MARE.

AFFILIATED STUDENT:—

Grammer, J. M. ...35a, Dartmouth Park Avenue, LONDON, N.W.5.

Exhibits.

The list of exhibits proved to be even more numerous than in recent years, and it was accordingly found necessary to limit each speaker to three or four minutes.

Mr. R. O. SUTHERLAND, who was responsible for the opening item, briefly described the new Architectural Lighting Room at the Bureau, which was examined and admired after the meeting.

Mr. R. F. WILSON, Art Director and General Manager of the British Colour Council, presented the new Dictionary of Colours published this year in which many shades of colour are reproduced, analysed and described.

Mr. GALLEY (E.L.M.A. Lighting Service Bureau) described the new "coiled coil" incandescent lamp, and demonstrated its efficiency as compared with lamps of the ordinary variety.

Electrical Discharge Lamps based on the use of mercury vapour were demonstrated by Mr. C. BICKNELL (Siemens Electric Lamps and Supplies, Ltd.), Mr. E. L. DAMANT (General Electric Co., Ltd.), and Mr. L. J. DAVIES (British Thomson Houston Co., Ltd.). Special interest was expressed in the new 250 watt lamp and in the horizontal burning lamp, only quite recently introduced. Mr. R. P. SAYERS (Philips Lamps Ltd.), showed several types of electric discharge lamps using sodium vapour.

New forms of fittings were shown and described by Mr. C. BICKNELL, Mr. E. STROUD (Holophane Ltd.), Mr. H. LONG (Benjamin Electric Ltd.), and Mr. J. M. BARNICOT and Mr. R. O. ACKERLEY (General Electric Co., Ltd.), whilst Mr. HAROLD BRIGHT exhibited some original hospital lighting equipment.

Local units, enabling high illuminations to be obtained with shielded lamps placed quite near to the object was shown by Mr. COOPER (Mek-Elek Engineering Ltd.). Architectural tubular lamps, in varied shapes, colours and sizes, were shown by Mr. C. J. CURRY (British Thomson Houston Co., Ltd.).

Photometric apparatus was exemplified by a new form of Brightness Meter shown by Mr. J. M. WALDRAM (General Electric Co., Ltd.), and by a simple and ingenious type of direct-reading illumination-photometer which Mr. CAWTHORNE, of the Weston Electrical Instrument Co., Ltd., described.

A feature of the proceedings was the display of a series of gas lamps. For this purpose gas mains had been specially introduced into the theatre—a courteous action of the Director which enabled gas lamps to be shown in action in the theatre for the first time. Amongst those who took part in this section of the exhibition were Mr. HEATHES (James Keith and Blackman Co.), Mr. A. R. MCGIBBON (Messrs. Wm. Sugg and Co., Ltd.), Mr. E. STROUD (Holophane Ltd.), Mr. EDGAR (Edgar and Sons), Mr. WILKES (C. H. Kempton and Co.), Mr. W. C. J. DAVEY (Parkinson Stove Co.), and Mr. FALK (Falk Stadelmann and Co., Ltd.).

The majority of these exhibits were again displayed at special meetings held in Birmingham on October 11, and in Liverpool on October 16, when addresses were given respectively by Mr. C. W. SULLY and Mr. A. W. BEUTTELL.

(Our next issue will contain the Report of Progress, an illustrated description of the exhibits, and a fuller account of the proceedings of the meetings in Birmingham and Liverpool.)

Presidential Address*

by

H. HEPWORTH THOMPSON

Gentlemen,—I preface my remarks by the expression of my appreciation of the signal honour you have paid me in my election as President of the Society for the ensuing year. This appreciation is tinged with a certain amount of regret that you have not chosen someone of our members who, by reason of the technical knowledge which I lack, is more fitted for the occupancy of the chair.

The position, however, being what it is, I have necessarily to do my best to give you satisfaction. Not being qualified to give you a technical address, I must address you from another angle, and I therefore propose to confine my remarks to the following three heads:—

WHAT HAS BEEN DONE IN ILLUMINATION?
WHAT IS BEING DONE?
WHAT SHOULD BE DONE?

all with particular reference to the operation of this Society.

In connection with the first heading, many of you will doubtless recall that the first illuminating engineering society was founded in the United States of America some thirty years ago, and in the establishment of which the engineers of my company took a prominent part. This was followed a year or two later (1909) by the organisation of our own Society, and, in turn, by such like organisations in France, Germany, Holland, Japan, Australia, and other countries. When the late Mr. Leon Gaster first took charge of this Society lighting as a science was unknown, and the task of developing a correct technique of lighting an uphill one of the last degree. Mainly due to his enthusiasm progress was made little by little with the help of those interested in the movement, until, finally, the Government of the day enlisted the aid of members of the Society in several directions.

It thus became the centre of the movement of scientific lighting. In the meantime, with the initiation of the Journal, an organ for propaganda became available. The habit of rule-of-thumb lighting had become so general previously that for a long time the results in the shape of better lighting were not apparent, but by degrees the steady process of educative propaganda began to bear fruit.

At the time of Mr. Gaster's death in 1928 much had been accomplished, particularly in bringing together gas and electricity within the confines of the Society. This has resulted in lighting being dealt with as such, independent of whether the source of illumination was one or the other. It has also had the happy effect of providing a platform where representatives of these two branches of illumination could meet, though there is still much work to be done on both sides to ensure the active support of the Society's work generally. This naturally leads me to the second of my divisions.

What is Being Done? To that question there can be but one answer, and that—Much is being done. From the business point of view, since Mr. Dow so ably took up the reins of secretaryship, the membership has been largely increased and the finances of the Society have been brought into a thoroughly satisfactory condition, and to-day both of those conditions are progressive. From a technical point of view, good work is being done both by initiative and collaboration, and on every side one sees the growth of lighting knowledge. While at the initiation of the movement but one firm had a technical illumination department, to-day there is hardly a firm of any standing in the lighting world but has its own. Naturally, with all the propaganda resulting, there has come an improvement in the " lighting mind " of the world at large, so that to-day, although there are still many examples of inefficient installations, yet the general position has greatly improved. The original somewhat modest standard of illumination of earlier days has been replaced by a higher one, and with it a corresponding improvement in efficiency and appearance has taken place. In streets, in schools, in works, churches, banks, offices, and in almost every domain of human life is the result apparent, not only in the higher values of illumination mentioned above, but in the enhanced technique of lighting itself. It would seem, therefore, our efforts have to some extent been rewarded. This brings me to the third question of my address, and possibly to varying opinions between you as to the advisability of some of the suggestions I am putting forward.

What Should be Done?—From what I have already said, it might be imagined that I am satisfied with the progress made, but, frankly, I am not, for I am ambitious for and jealous of the Society's welfare. Therefore, as the first and most important item, I would suggest to you the importance of having a policy with which to guide our deliberations and shape our future. So far, the absence of definite aims has led us to drift somewhat, with the natural reaction that the place which is ours and which we ought to fill as the leaders of the illumination field has been somewhat diverted in other directions.

In order to remedy this position, I suggest to you that our first aim should be independence complete and unfettered. For this we need a sufficient membership and financial resources to enable us to meet *all* our requirements. I appreciate that substantial improvement in this respect has been made during the past few years, notably in securing the adhesion of the various firms and bodies which figure in the list of sustaining members, but I feel that this list should be considerably extended so that all sections of the lighting industry may be represented, and I also observe that the support thus forthcoming—as also in the ordinary membership of the Society—is derived very largely from those concerned with the manufacture of lighting equipment.

Our future aim should surely be to draw into our membership a larger number of those who, as consultants, are professionally interested in lighting, for example, consulting engineers, engineers in charge, contractors, and others who act as links between the manufacturers and the public. Further, we should strive to enlist the co-operation of those who are primarily consumers and users of light, whom we desire to interest in our work, and whose comments thereon would often be helpful. I should like this to

* (Address delivered at the Opening Meeting of the Illuminating Engineering Society, held at the E.L.M.A. Lighting Service Bureau, 2, Savoy-hill, London, W.C.2, at 6 p.m., on Tuesday, October 9, 1934.).

be achieved in part by each individual of the Society present or absent making a pledge with himself to obtain at least one additional member this year, and in particular I would stress the need for increased support from the gas industry. The attainment of this would give us a membership of over a thousand, and thus place us in a fairly sound position for the moment, though, I by no means visualise this as a limit. Through the efforts of your Membership Committee there has been a considerable accession of members during the past year, but I am satisfied that its work would result in greatly increased success if all members would individually give their support.

As and when this aim is realised, I would like to see a serious attempt made to raise the standard of the Society and the Journal in such a manner that contributors of high technical standing would be attracted to both, and in this way give greater weight to the value of the Society and its publications. In particular, I would like to stress the importance of original communications, embodying the results of research, such as at present figure too infrequently at the Society's meetings. I would like to establish the belief that on the Society's platform the very latest developments are recorded and that information is there available such as could not readily be obtained elsewhere.

Again, when the numbers of members have increased sufficiently, I suggest that consideration be given to the standard of election to the Society, and that in due course examination or selection might be practised before full membership is given. Further, I would like to suggest that consideration be given to the possibility of instituting a Fellow grade of membership so that we should be able to offer the title of Fellow to those who by long membership, combined with high technical qualifications or work of special merit for the Society, deserved this form of special recognition.

The next suggestion I put to you is that we should have our own regular meeting place. It is not becoming to the dignity of the Society, nor to our freedom, if we are driven about from place to place for the purpose of holding our monthly meetings, and I suggest that it should be a definite part of our policy to rent or own a building or part of a building which we could look upon as our own.

When this is done it is fitting that provision be made for the establishing of a library of books of reference on all matters appertaining to lighting, so that such books might be available to the members of the Society at all reasonable times.

I come now to another ambitious suggestion, and that is in view of the world-wide spread of illumination and the need of keeping in touch with outside developments, that a travelling scholarship for £250, tenable for one year, should be initiated, which would not only serve the purpose indicated, but also encourage the best young brains to strive for it in the hope that the adoption of illuminating engineering as a profession, both from a research and livelihood point of view, might be a profitable one.

Alternatively, that some financial arrangement be made with a University or Technical College for the institution of a Post Graduate Scholarship to permit of independent research being made and the results achieved given to the industry generally. It may be said that this is already being done elsewhere, but I venture to suggest that it is more in the interest of the profession to have such work done under our own control.

I come now possibly to a point where a good many of you will join issue, and I ought, perhaps, to make it clear that the suggestions I am about to make express simply my own personal view. I referred just now to the fact that some of our responsibility has been diverted from us by the encouragement of other movements, which have resulted in the establishment of outside bodies who serve practically the same purpose. I speak specifically of the Association of Public Lighting Engineers, the National Illumination Committee, the International Commission on Illumination, and any other body which deals with the subject of illumination in any form. In my opinion, notwithstanding the fact that we are represented on these bodies, it should be our policy, if we really are leaders in the lighting field, to endeavour either by absorption or amalgamation to bring them all into one composite body, and that body the Illuminating Engineering Society.

Gentlemen, we are plagued by the number of committees or societies of one kind or another, so why we should need more than one for lighting I don't know, and I shall be very interested in learning what you have to say of this particular proposal. I know there are all sorts of obstacles in the way, but I feel that attempts should be made and persisted in until our Society is recognised as the one and only body entitled to speak with authority on illumination in all its aspects.

I am of opinion, too, that we should have at least once a year a regular course of lighting instruction dealing with all the aspects of illumination, such courses to be made up of addresses given by different members of the Society, or preferably by Fellows, if that idea is adopted. We are all aware that this is already being done in various other directions, but such efforts naturally are not primarily designed to express the views of the Society. I feel, therefore, that we as a Society should take the initiative in seeing that a quite impartial, instructive, authoritative, and modern form of course on illumination should be provided. This might take the form either of a regular course of lectures, or an annual convention in which all lighting bodies might join together.

And, lastly, I come to the final item of a suggested policy, which relates to the means to be taken to make known the work of the Society, and "to place it on the map." It has long been felt by me that the Society itself is not nearly as well known as it should be, nor does its work receive the attention on the part of the general public which it deserves. Our first step, I suggest, should be to appoint someone to act as a publicity agent on behalf of the Society, and to remedy this defect.

Next, I feel that the time is coming when the method of publishing and presenting its transactions should be reconsidered. I have nothing but admiration for the very able editor of the Journal in which these transactions appear. The fact that he is also the Hon. Secretary of the Society has ensured a common policy, and undoubtedly the present arrangement has served the Society well.

But we have to face the possibility of changes in the future, and there are two suggestions which I would like to offer. In the first place, it is, I think, evident that the Journal has hitherto had to serve two functions which can only be combined with some difficulty—that is, to record the papers and discussion of the Society, frequently of a highly technical character, and to serve as a medium of popular exposition to those outside the Society, who require less serious provender. Here, again, I would like to express my admiration for the ingenuity with which this dual task has been performed, but it seems probable that the combination will become more and more difficult as time goes on.

I suggest, therefore, that ultimately the two functions should be separated—that is to say, the Transactions of the Society should be issued separately, with all the attention to dignified form, accuracy, and scientific character desirable, and distributed to members; and that the Journal should operate as a popular medium for conveying information on lighting to a wider circle. Both should be available to all members of the Society, but the Journal would naturally have a wider field to cover, and would circulate amongst people outside the ranks of the Society, as it does at present. The Society should then assume control of the publica-

tion of its own Transactions, and, so long as the Journal was accepted as the official journal of the Society, issued to all its members, giving the essence of its deliberations, and popularising its ideals, the Society should have some voice in its management. I realise that such a step would require careful study, and that it might involve the Society in increased expenditure, but I see no reason why it should not be effected, so soon as the needful increase in membership is obtained.

I come now to my end, and hope that the suggestions, crude as they are, may have aroused such interest in you as the future of the Society does to me, and, as a means of guidance to the Council, I shall be glad to learn of your views in regard to all or any of the ideas put forward.

I feel confident that your wishes lie in the direction of the Society's progress, and that you are in no way content that it should occupy any other position than that of first in the lighting field; therefore the issue as to its ultimate end is in your hands.

Concluding, I again thank you for the honour you have paid me in electing me as President, and, in return, subject to lack of technical knowledge, I will do my best to give you satisfaction.

Literature on Lighting

(Abstracts of Recent Articles on Illumination and Photometry in the Technical Press)

(Continued from page 315, October, 1934)

I.—RADIATION AND GENERAL PHYSICS.

279. Direct Determination of Energy Curves for Various Radiations.

Anon. R.G.E., 36, pp. 370-372, *September* 15, 1934.

Resumé of an article in the "Bulletin de la Société française de Physique," May 18, 1934. W. R. S.

280. Spectral Distribution of Energy in Common Illuminants.

A. H. Taylor. Gen. El. Review, 37, pp. 410-413, *September*, 1934.

Classifies illuminants as to their spectral characteristics and illustrates the energy distribution for tungsten light, daylight, and artificial daylight. The author discusses the production of coloured light by the employment of colour filters with tungsten light. G. H. W.

281. A Specification of Whiteness.

D. L. MacAdam. J. Opt. Soc. Amer., 24, pp. 188-191, *July*, 1934.

The author claims that the method described is a straightforward extension of the standardised method of objective colour specification. F. J. C. B.

282. Ultraviolet Sources and their Radiation.

W. E. Forsythe, B. T. Barnes, and M. A. Easley. J. Opt. Soc. Amer., 24, pp. 178-182, *July*, 1934.

The intensities of the principal lines and also the total amount of ultraviolet radiation of several different types of source are given. A new basis of rating ultraviolet light sources is explained and the ratings of a number of sunlamps in terms of these new units are given. F. J. C. B.

283. The Absorption of Ultraviolet and Visible Light by Water.

L. H. Dawson and H. O. Hulbert. J. Opt. Soc. Amer., 24, pp. 175-177, *July*, 1934.

The absorption coefficient of chemically pure, fairly dust-free water was measured by photographic photometry by using tubes of water up to 272 cm. long. Measurements were made between wave lengths 2000 A and 6900 A. F. J. C. B.

II.—PHOTOMETRY.

284. A Reflectometer for all Types of Surfaces.

F. Benford. J. Opt. Soc. Amer., 24, pp, 165-174, *July*, 1934.

The spherical part of the instrument is composed of two magnesium carbonate blocks in which hemispherical cavities have been bored. Means are provided for attaching the reflectometer to a direct vision photometer. Photographs and a description of the design are given together with results of measurements made with the instrument. F. J. C. B.

285. Illumination Instruments.

H. Cobden-Turner. El. Times, 86, p. 393, *September* 27, 1934.

Describes and illustrates various photoelectric photometers. W. R. S.

286. Miners' Lamps, Photometers.

Anon. World Power, 22, p. 181.

A description is given with photographs of photometers, both directional and integrating, that are now available for the measurement of candle-power from miners' lamps. C. A. M.

287. A New and Simpler Method for the Presentation of Photometric Data of Street Luminaires.

S. McK. Gray. Am. Illum. Eng. Soc. Trans., 29, pp. 463-472, *June*, 1934

Briefly reviews a number of previous proposals for the determination and presentation of street lighting data, and formulates a new one which, the author claims, possesses the advantage of extreme simplicity and convenience. G. H. W.

288. Standard Lamps for the Spherical Photometry of the Sodium Arc.

Frank Benford. Gen. El. Review, 37, pp. 342-344, *July*, 1934.

Describes the use of a colour filter, which has been partially corrected to give a colour match with sodium light when using an incandescent standard. The results obtained from a series of observers are given. Also describes the design and calibration of a sodium-coloured standard and illustrates the apparatus used in the photometry of sodium lamps. G. H. W.

III.—SOURCES OF LIGHT.

289. Light—Modern Lamps.

E.O.T. Elect., 113, p. 365. *September* 21, 1934.

The modern incandescent and gas discharge lamps are discussed in detail in a concluding article of a series dealing with methods of light production. C. A. M.

290. Tube Lamp Lighting.

Anon. Elect., 113, p. 445, *October* 5, 1934.

Particulars are given of the various types of architectural lamps now available, and discusses their suitability for lighting schemes. C. A. M.

291. Better Service by Group Lamp Replacement.

W. P. Lowell, Am. Illum. Eng. Soc. Trans., 29, pp. 697-703, *September*, 1934.

Group replacement of lamps is defined, and the resultant advantages set down. Various applications are described, and the uniformity of the modern incandescent lamp, which makes group replacement practical, is illustrated. G. H. W.

292. Special Types of Electric Lamps.
H. Péchaux. R.G.E., 36, *pp.* 395-402, *September* 22, 1934.

Notes on the electrical and photometric characteristics of (1) internally frosted, and (2) twin filament lamps, indicating some of their particular advantages. W. R. S.

293. Sun Lamps.
Licht u. Lampe, 23, *p.* 457, *September* 13, 1934.

Details are given of some American, English, and German sun lamps. E. S. B-S.

294. The Design of Tungsten Springs to Hold Tungsten Filaments Taut.
K. B. Blodgett and J. Langmuir. Rev. Scient. Instruments, 5, *pp.* 321-333, *September,* 1934.

The problem of designing a spring of proper dimensions, and of mounting it under proper tension, is discussed. The paper contains considerable information on the properties of springs relative to the tensile strength of the filament, and provides data for designing helical springs and springs for special purposes. F. J. C. B.

295. The Relation of the High-Intensity A-C Arc to the Light on the Projection Screen.
D. B. Joy and E. R. Geib. J. Soc. Mot. Pict. Eng, 23, *pp.* 35-37, 1934.

The influence on intensity and distribution of light on the projection screen of the following factors has been measured and is discussed—change of position of arc with respect to reflector, varying arc length, decreasing current, and irregular feeding of carbons. Proper draught conditions in the lamp house, are important. The wave-form of the light on the screen (projector shutter not operating) has been measured by means of an oscillograph for various alternating current carbons. The unique wave-form furnished by the high intensity carbons is discussed. [Photog. Abs., 14, p. 155, No. 906, 1934.] F. J. C. B.

296. Reignition of an Arc at Low Pressures.
S. S. Mackeown, F. W. Bowden, and J. D. Cobine. Elect. Engineering, 53, *pp.* 1081-1085, *July,* 1934.

An investigation of factors influencing the reignition potential of an alternating current arc at low pressure is reported in this paper. The investigation was undertaken to determine if such data could throw more light on the transition from a glow discharge to an arc. S. S. B.

297. Production of Light from Discharges in Gases.
Saul Dushman. Gen. El. Review, 37, *pp.* 260-268. *June,* 1934.

Presents the fundamental aspect of gaseous-discharge lamps, including discussion on the visibility factor of radiation, the electrical phenomena and luminous efficiences of incandescent solids. and of gaseous discharges. G. H. W.

298. Distribution of Light from Gas and Vapour Discharges.
H. C. Rentschler. Am. Illum. Eng. Soc. Trans., 29, *pp.* 439-443, *June,* 1934.

A short article on the production of light from some of the more common gases and metallic vapours. The distributions of radiation over the visible spectrum for these discharges are illustrated. G. H. W.

299. Low Pressure Gaseous Discharge Lamps.—Part II.
Saul Dushman. Elect. Engineering, 53, *pp.* 1283-1296, *September,* 1934.

This is the second part of an article dealing with radiation and conduction phenomena in low-pressure gaseous discharge lamps. (See Abstract 253.) This section deals with electrical conduction processes. S. S. B.

300. Fundamental Phenomena in Sodium-vapour Lamps.
C. G. Found. Gen. El. Review, 37, *pp.* 269-277, *June,* 1934.

Describes the characteristics of the sodium-vapour lamp and illustrates the effect of bulb temperature on the lumen output of the discharge. Notes are included on the general classification of gaseous discharges. G. H. W.

301. The A-c. Sodium-vapour Lamp.
Dr. G. R. Fonder and A. A. H. Young. Gen. El. Review, 37, *pp.* 331-341, *July,* 1934.

Describes the design and construction of a 10,000-lumen A-c. lamp and its use in highway lighting. The variation of luminous characteristics with current and the effect of cooling are illustrated. G. H. W.

302. Operating Characteristics of Sodium-vapour Lamps.
Dr. N. T. Gordon. Gen. El. Review, 37, *pp.* 338-341, *July,* 1934.

Describes and explains the operating characteristics of the 4,000-lumen (d-c), the 10,000-lumen (a-c), and the 1,000-lumen (a-c) sodium lamps. Test data is given for each lamp prepared from the results of batch tests. G. H. W.

303. Circuits for Sodium-vapour Lamps.
W. F. Westendorp. Gen. El. Review, 37, *pp.* 368-371, *August,* 1934.

Describes and explains the design of series and multiple operation a-c and d-c circuits, and deals with the reduction of radio interference to an imperceptible level in them G. H. W.

IV.—LIGHTING EQUIPMENT.

304. British Standard Specification for Internally Illuminated Yellow Diffusing Globes for Traffic Control Signals, No. 566—1934.

The specification deals with the material and dimensions of globes and the colour of light transmitted, which is defined by formula. Mean hor. C. P., brightness and non-visibility of filament are also specified. Tests prescribe relate to selection, colorimetric properties and mean horizontol C. P. J. S. D.

305. Automobile Headlights.
A. Monnier and M. Mouton. Lux, VII., p. 99, *September,* 1934.

Completion of contribution initiated in previous issue. The authors discuss in turn the theory of projectors, and their testing, design, and manufacture. J. S. D.

306. Some Characteristics of Reflecting Surfaces.
F. Benford. Gen. El. Review, 37, *pp.* 414-415, *September,* 1934.

Describes the computation of specular reflection with reference to Fresnel's equation, and considers the measurement of reflection coefficient, and the maximum angle of incidence experienced in some of the more common uses of specular reflectors. G. H. W.

307. Report of the Joint Committee on Illuminating Glasses.
Am. Illum. Eng. Soc. Trans., 29, *pp.* 677-685, *September,* 1934.

Section A of this report is concerned with studies of the illuminating performance of various glasses and their nomenclature. A recapitulation of the definitions and nomenclature previously adopted by the Committee is included. G. H. W.

308. Horizontal Lanterns for Electric Discharge Lamps.
R. Maxted and L. J. Davies. Elect. Review, 115, *pp.* 111-112, *July* 27, 1934.

A description is given of a new lantern in which a 400 w. gaseous discharge lamp is burnt horizontally. C. A. M.

309. Flameproof Lighting Equipment.
Anon. El. Times, 86, *p.* 363, *September* 20, 1934.

Describes various fittings for use in explosive atmospheres; photographs are given. W R. S.

310. Design of Mobile Colour Apparatus.
G. A. Shook. Am. Illum. Eng. Soc. Trans,. 29, *pp.* 425-438, *June,* 1934.

Describes the design of a manually controlled projection-type mobile colour-apparatus, and discusses its applications. G. H. W.

V.—APPLICATIONS OF LIGHT.

311. The New Science of Lighting.
M. Luckiesh and Frank K. Moss. Am. Illum. Eng. Soc. Trans., 29, *pp.* 641-674, *September,* 1934.

Discusses a new science of lighting evolved from the new science of seeing. G. H. W.

312. Light, Vision, and Luminous Sources.
L. J. Robertson. Australian Engineer, 34, *p.* 16, *August* 7, 1934.

Summary of paper read before the Illuminating Engineering Society of Australia. The process of vision

and effects of glare are explained, and a summary of modern illuminants, including gaseous discharge lamps, is given. J. S. D.

313. Light Distribution and Control.
C. L. Barnes, Australian Engineer, 34, *p.* 14, *August* 7, 1934.

Summary of paper read before the Illuminating Engineering Society of Australia. The nature of polar curves and isocandle diagrams is explained, and examples of simple calculations are presented. J. S. D.

314. Illumination Values.
K. M. Kharegat. Elect. Rev., 115, *pp.* 273-274, *August* 31, 1934.

Various graphical methods for the conversion of polar curves of light distribution into a distribution of illumination values are given. C. A. M.

315. An Extension of the Dewey Decimal System of Classification as Applied to Illuminating Engineering.
A. A. Slobod. Am. Ill. Eng. Soc. Trans., 29, *pp.* 509-604, *July,* 1934.

The author extracts from the main Dewey Decimal System that number which deals with aspects of the lighting art as a whole, and describes a method whereby this can be subdivided to provide a file of literature pertaining to lighting. He also includes Dewey tables of other subjects of general interest to the illuminating engineer. G. H. W.

316. The Home of To-morrow.
A. C. Dick. Am. Illum. Eng. Soc. Trans., 29, *pp.* 455-462, *June,* 1934.

The author outlines the purposes of the "Home of To-morrow" at Mansfield, Ohio, and describes its constructional details, together with the lighting facilities provided in the various rooms. G. H. W.

317. Modern School Lighting.
G. Gleeson. Elect. Rev., 115, *p.* 473. *October* 12, 1934.

Present-day practice in school lighting is discussed. Photographs are given. C. A. M.

318. Lighting Service.
Anon. El. Review, cxv., No. 2,964, *p.* 344, *September* 14, 1934.

Describes the new demonstration and lecture-rooms of the E.L.M.A. Lighting Service Bureau. J. M. W.

319. The Influence of "Built-in" Lighting Forms on Direct Lighting Methods.
H. L. Logan. Am. Illum. Eng. Soc. Trans., 29, *pp.* 686-696, *September,* 1934.

Some of the possibilities and problems involved in the use of direct lighting with "built-in" media are discussed, and several of the more important factors summarised. A number of installations are illustrated and analysed. G. H. W.

320. Road Illumination.
L. J. Davies and R. Maxted. Elect., 113, *p.* 390, *September* 28, 1934.

A brief summary is given of a paper read by the authors to the British Association on conditions governing good street lighting. C. A. M.

321. Main Road Lighting Research.
A. F. Loewe. World Power, 22, *p.* 170, *October,* 1934.

A brief summary is given of recent investigations by the U.S. Highway Research Board into the visibility conditions resulting from street lighting by both tungsten and luminous discharge sources. C. A. M.

322. Croydon Street Lighting Development.
Anon. Elect. Rev., 115, *p.* 492, *October* 12, 1934.

A brief description is given of a new street lighting installation in which the lamps in each lantern are three 150 w. incandescent lamps with a mercury vapour lamp taking only 250 watts. C. A. M.

323. Automatic Street Lighting Control.
Anon. El. Review, cxv., No. 2,964, *p.* 340, *September* 14, 1934.

Describes a selenium bridge controller for the operation of street lights, in which the use of amplifying valves has been avoided. J. M. W.

324. Sodium-vapour Highway Lighting on Balltown Road at Schenectady, N.Y.
George A. Eddy. Gen. El. Review, 37, *pp.* 372-377, *August,* 1934.

A description of the lighting and control equipment employed in the Balltown Road installation, with illustrations and photometric data. G. H. W.

325. Luminous Road Traffic Signals (Illustrated).
Capt. W. J. Liberty. Highways and Bridges, Vol. I., No. 16, *pp.* 10-11, *September* 25, 1934.

A brief description with illustrations of some of the latest installations of illuminated traffic signals in the thoroughfares of the Metropolis. Notes on preventable accidents, accidents preventable by traffic signals, traffic density and illuminated signals, the various systems of control with their special functions, pedestrian-operated signals, hours of operation, extraneous lights, standardisation, motorist's vision when driving, up-to-date methods. W. J. L.

326. Seaside Illuminations.
Anon. El. Times, 86, *p.* 307, *September* 6, 1934.

Description, with photographs, of lighting at Southend-on-Sea. W. R. S.

327. Adaptation of Lighting to Working Conditions.
W. Kircher. Licht und Lampe, IV., p. 185, *October* 15, 1934.

Local lighting is most frequently needed when exceptionally high illumination is desired, when troublesome shadows on the work may be caused by general lighting, and when contrast-conditions, shadows, and images in polished material are of importance. Typical instances are the examination of glass for flaws and the study of textile material. Photographs illustrating such conditions are reproduced. J. S. D.

328. Correct Lighting in Stores.
P. Warrender. Elect. Rev., 115, *pp.* 303-304, *September* 7, 1934.

The various requirements of shop window and interior lighting are discussed in detail. Suggested relations are given between wattage per foot run and the situation of the shop window. C. A. M.

329. The Neon Gallery for 1934.
Signs, VIII., p. 9, *October,* 1934.

Photographs of a series of twenty notable neon advertising signs installed in 1934 are reproduced, and a brief description is attached in each case. J. S. D.

330. Garden Floodlighting.
G. Gleeson. Elect. Rev., 115, *p.* 76, *July* 20, 1934.

The floodlighting of gardens is discussed. Photographs are given C. A. M.

331. Lighting of the Cheddar Gorge.
Anon. Elect., 113, *p.* 419, *September* 28, 1934.

A brief description is given, with a photograph of the floodlighting of the Cheddar Gorge. C. A. M.

332. Scarborough Open-Air Theatre.
Anon. El. Times, 86, *p.* 346, *September* 13, 1934.

Particular reference is made to the lighting of the "Hiawatha" pageant, over 300 kilowatts being employed for the lighting. W. R. S.

333. The Negative Glow Electroscope.
M. Abadie. R.G.E., 36, *pp.* 363-367, *September* 15, 1934.

Describes an apparatus designed for observing periodic currents by means of a luminous tube whose light column length is proportional, at any instant, to the current in the tube. W. R. S.

Recent Patents

(Abstracts of recent Patents on Illumination & Photometry.)

415,483. "Improvements in Electric Lamps of the Gaseous Discharge Type."

Rennerfelt, I., March 2, 1932 (Convention, Sweden).

This specification describes a gaseous discharge tube for low voltage, 110-250 v., A.C. or D.C., comprising a long narrow tube filled with gas at low pressure, such as mercury, nitrogen or hydrogen, or a mixture, and having two or more spiral electrodes extending throughout the length of the tube and passing through the wall of the tube for connection to a supply. One at least of the electrodes is close to the wall of the tube. The electrodes may be intertwined and may be coated with oxide of barium, strontium, or the like, or of sodium or potassium. An interior core of glass or the like may be provided, the electrodes being disposed between the core and tube wall.

415,497. "Improvements in or relating to Selenium and like Cells."

Chilowsky, C., March 17, 1932, February 11, 1933 (Convention, France. One Complete Specification).

This specification describes the manufacture of selenium and like cells of the condenser type by assembling thin metallic and thin insulating sheets to form a block which is impregnated with insulating material. The surface of the impregnated block is polished and photo-sensitive material is deposited thereon. The block may be formed by rolling up together insulating and conducting sheets and the rolled block may be cut into sections, each to form a cell.

415,536. "Method of Producing Luminescent Glass."

Fischer, M., Fischer, M., and Fischer, H., May 9, 1932, May 9, 1932, December 15, 1932 (Convention, Germany. One Complete Specification).

According to this specification, glass which emits light when subject to excitation by irradiation is produced by adding to glass a quantity of zinc-, calcium-, barium-, or strontium-sulphide or a mixture of these and a quantity of heavy metal such as manganese, copper, bismuth, thallium, rubidium, lead, antimony, cadmium, tungsten, etc. Luminous earth alkali or zinc sulphides are formed in the glass. Carbonates or oxides and sulphur may be added to produce the sulphides. Various formulae for producing different coloured luminescence are given in the specification.

415,613. "Improvements in or relating to Devices comprising at least one Electric Discharge Lamp."

N. V. Philips Gloeilampenfabrieken, November 15, 1932, March 31, 1933 (Convention, Germany. One Complete Specification).

This specification relates to glow discharge lamps using vapour of difficult vaporisable metal and describes an arrangement in which one or more such lamps, each comprising an elongated glass tube, is surrounded by an envelope, which may be double walled, the space between the lamp and the envelope being exhausted. The elongated lamps are eccentrically arranged in the envelope and, if more than one, are arranged close together so that their adjacent sides radiate heat to each other.

415,617. "Improvements in or relating to Vehicle Lamps."

Robert Bosch Aktiengesellschaft, December 24, 1932 (Convention, Germany).

This specification describes a head-lamp in which a dispersing disc is located between the light source and front glass, such that rays falling upon it approximately parallel from the middle portion of the lamp are deflected partly laterally and partly laterally and downwards. The dispersing disc may be of ribbed glass, either plain or curved. It may obstruct the whole of the rays proceeding directly from the light source to the front opening of the lamp.

415,725. "Improvements in Miners' and Like Safety Lamps."

Hailwood, E. A., November 28, 1932 (Divided from No. 414,420).

This specification describes a miner's oil safety lamp with an external reflector arranged to be directly behind the flame of the lamp and to be movable around the lamp upon a fixed or movable air inlet guard. The reflector may be hinged to the air inlet guard or move in slides thereon.

415,873. "Improvements in or relating to Lamp Shades." *Brown, J. E., June 27, 1933.*

The specification covers a lamp shade of the kind comprising a hollow body of glass or the like surrounding the lamp, and laterally extending fins carried on the body, in which the laterally extending fins are each carried by a separate projection formed integrally with or permanently attached to the hollow body and spaced apart from each other, and the lower fins extend further than those above them. The fins may each be a flat annulus of translucent material.

415,914. "Improvements in or relating to Anti-Dazzle Devices for Use on Vehicles."

Miller, A. L., and Helme, E. T. L., April 19, 1933.

This specification describes a lamp to be attached to the off rear quarter of a vehicle to illuminate the road behind and on the offside of the vehicle so that the driver of another vehicle travelling in the opposite direction shall be afforded light in the area not covered by the headlamps, avoiding the abrupt transition from the glare of headlamps to total darkness. The lamp comprises a linear or multi-point light source in a reflector which directs the light downwards and outwards to illuminate the road surface over approximately a quadrant.

415,964. "Improvements in Street Lighting Apparatus."

Zeiss Ikon Aktiengesellschaft, March 11, 1933 (Convention, Germany).

The specification describes a street lighting device having two incandescent lamps, each provided with a separate mirror of non-circular form to reflect the light from a point source to illuminate an elongated or oval area. A light-diffusing screen, common to the two mirrors and lamps, may be provided.

Road Surface Reflection Characteristics and their Influence on Street Lighting Practice

by J. M. WALDRAM, B.Sc., A.C.G.I., F.Inst.P.

(Communication from the Staff of the Research Laboratories of the General Electric Company, Ltd., Wembley, England)

Paper presented at the Eleventh Annual Meeting and Conference of the Association of Public Lighting Engineers, held in Aberdeen during September 17th to 20th, 1934.

(Continued from page 313, October, 1934.)

(5) RESULTS.

At present, results have only been obtained for one surface, which was chosen as typical of a surface having useful reflection properties. Experience had shown that the reflection from this surface was sufficiently " spread " to produce wide streaks, and thus to enable a satisfactorily even distribution of brightness to be obtained. It was laid in accordance with B.S.S. 342, 1928. The wearing surface is composed of small gauge granite mixed with sand and bitumen, laid at the proper temperature, and consolidated by rolling. Before the mixture is too cold, pre-coated granite chippings are distributed over the surface. These chippings are of ¾" gauge Cornish granite coated with a very minute layer of bitumen. This surface is widely used at the present time, and, it is understood, its use is likely to be continued. The surface tested had had about eighteen months' wear.*

It will be realised at the outset that a great deal of variation occurs between one surface and another and even between different parts of the same surface, which have been differently worn. Precise and repeatable data are hardly, therefore, to be expected. All that can be hoped for is eventually to provide data for two or three characteristic road surfaces

* For the above information the author is indebted to Major W. H. Morgan. County Surveyor of Middlesex.

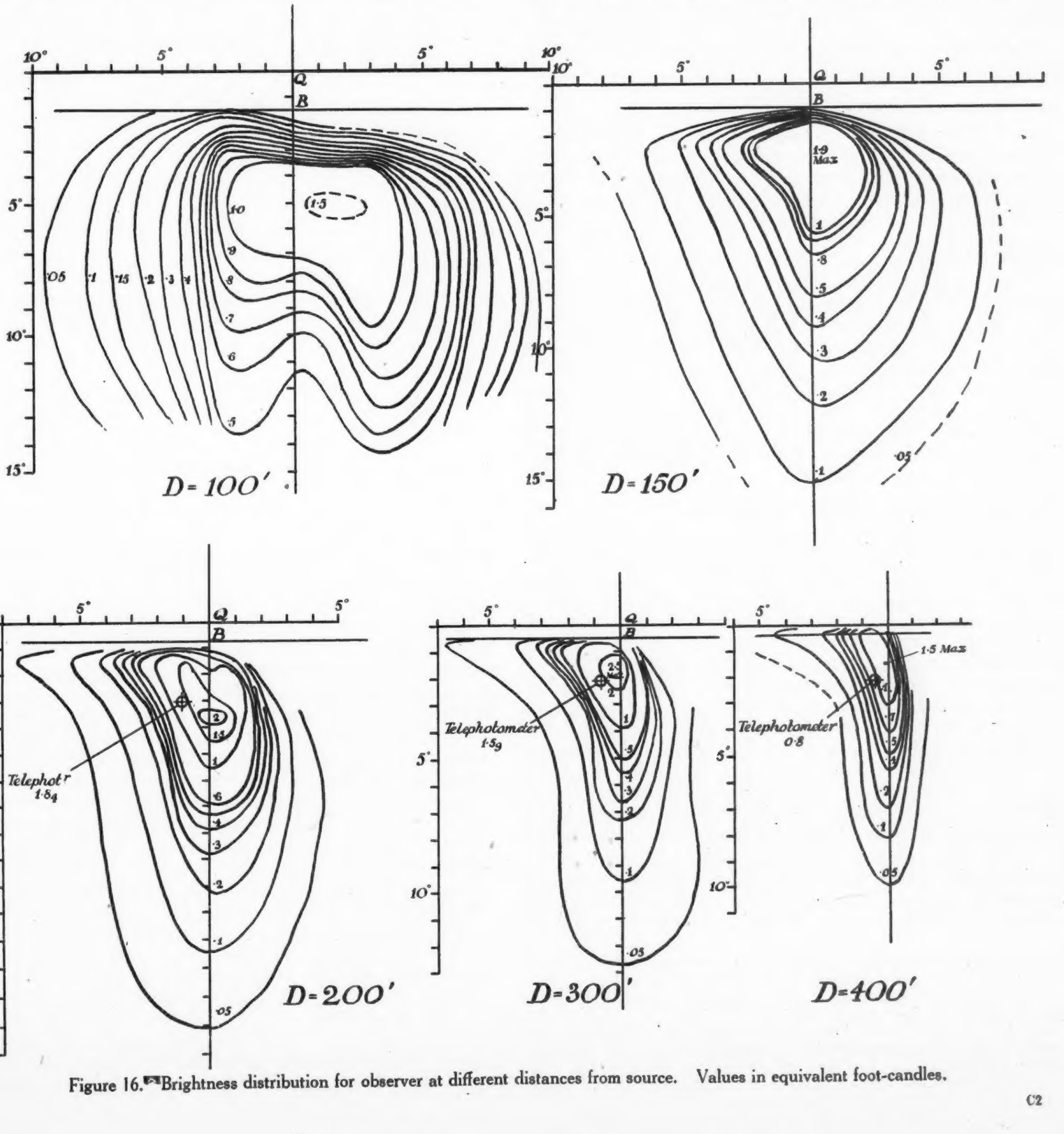


Figure 16.—Brightness distribution for observer at different distances from source. Values in equivalent foot-candles.

(e.g., of high polish, good "spread" reflection, and approximating to matt), and in practical application to use whichever data are the nearest to the particular surface concerned. The surface tested comes in the second class. In the experiments readings were obtained from a single unit, consisting of a 400-watt high-pressure mercury electric discharge lamp, in a lantern mounted over the kerb at 25 ft. height, having an asymmetric distribution.

It is convenient to express brightness in equivalent foot-candles (abbr. e.f.c.), the unit being the brightness of a perfectly diffuse reflecting surface having a total reflection factor of 100 per cent. and receiving an illumination of 1 foot-candle. The reflecting power of the surface will be expressed as a specific reflectivity—i.e., the ratio of the brightness of the actual surface to that of a perfectly diffusing surface of 100 per cent. reflection factor. A special assumption is made, however, which will be explained later.

The actual brightness distributions of the road surface from one unit are shown in Figure 16, for the five different distances indicated.* The investigation was made on the right-hand side of the road, and the road surface near the kerb was not worn and polished to the same extent as the surface further out; but the camera positions were chosen so that the streak was formed as far as possible on a uniformly polished part of the surface. A few check readings were made by telephotometer and are marked in the figure: it will be seen that they are in good agreement with the results obtained from photographs.

This series of results provides some interesting observations.

(a) Shape of Patch.

At 100 or 150 feet from the unit the patch is ill-defined and of large extent. As the distance increases, however, it begins to lengthen in the direction of the observer and to take up a characteristic ˥ shape.

(b) Brightness.

The maximum brightness does not vary very greatly; the highest value of 2.5 e.f.c. occurs at 300 feet, and the lowest of 1.5 e.f.c. at 100 feet and 400 feet. The brightness beyond the bright patch is of the order of 0.05 e.f.c. The values of maximum brightness are liable to considerable variation as a result of differences in degree of polish, and are not important. The minimum brightness is much more important, as determining the brightness of the dark parts of the road surface.

(c) Position of Maximum Brightness.

A very curious phenomenon may be observed in the position of the region of maximum brightness. It would naturally be supposed that the maximum brightness would occur at one of two positions—either where the illumination on the road is greatest, or centred about the region at which, if the surface were a mirror, an image of the light source would be formed. Actually the maximum brightness is at neither of these places, but the bright region begins at about 30 feet from the post in every case, and the maximum occurs there or a little beyond. The image point is found, curiously enough, to come near the end of the streak.† This latter conclusion is confirmed by observation of a large number of photographs and of actual installations. On a dry road, except when the surface is unusually highly polished, the streak extends only a little way beyond the image point, and it is generally unwise to rely on a streak of much greater length. It is easy to show‡ that the distance of the image point from the source is $D.H/(H + h)$, or from the observer, $D.h/(H + h)$. When the road is really wet, however, the image point may become the brightest point in the streak, which is then very narrow. The position of the maximum brightness is curious, and no physical explanation has so far suggested itself. The curves of brightness measured along the streak do not show the slightest resemblance to the curves of illumination on the surface (Figure 17). In fact, in calculating reflectivities, it becomes evident that the values obtained at large distances from the unit become very great—reflectivities are found of over 500 on this basis, even for the not particularly polished road investigated—simply because at these distances the illumination is so very low. At about 350 feet from the unit the surface brightness in the centre of the streak is well maintained, whereas the horizontal illumination has fallen as low as 0.0005 foot-candle.

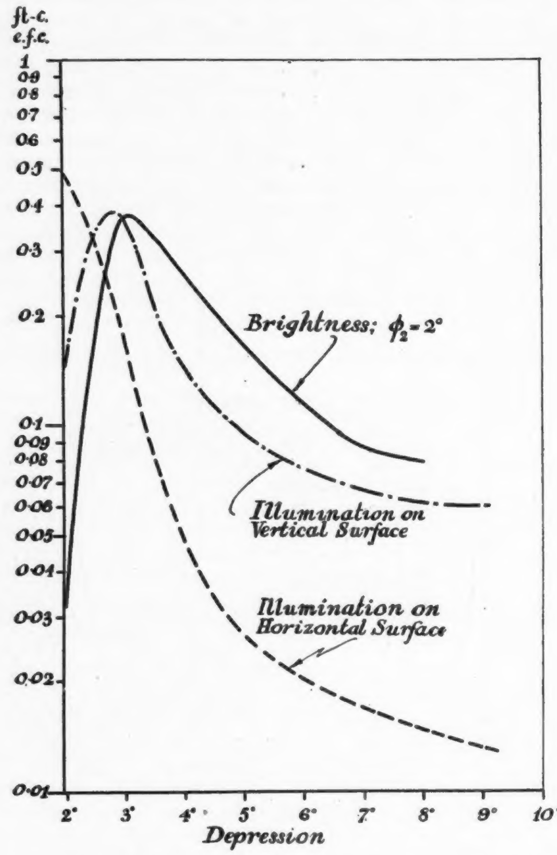


Figure 17. Brightness and illumination along length of streak; not on centreline.

In the first test made it was observed, however, that the brightness followed much more closely the curve of illumination on a vertical surface than on a horizontal, as can be seen in Figure 17. The position of maximum brightness is in this test very closely the position of maximum vertical illumination in each case. This is not illumination on a vertical surface as generally understood, for it is the illumination on a small vertical face on the road surface, on the side remote from the observer, which he would not be able to see. This follows the brightness much more closely than does the more conventional horizontal illumination, and has been taken as the basis of the reflectivities given below. The reason for this correspondence is not clear. There is not necessarily any real physical significance in the illumination on a vertical face. It also remains to be seen whether other surfaces show the same characteristic, which may turn out to be entirely fortuitous.

* It is hoped shortly to extend the investigation to 600 ft., but results are not available at the time of writing.

† Later work shows that when the surface becomes more polished the brightness maximum is closer to the observer and the value of brightness is higher. The maximum does not occur at the image point, however, unless the road surface is very highly polished or very wet.

‡ Waldram, A.P.L.E., 1928.

(d) Brightness of Road Surface beyond Source.

All the evidence, both from the tests made and from observation, goes to show that except on matt roads the brightness of the road surface beyond the post generally is negligibly small and cannot be relied upon as a background.

(e) Limit of Bright Streak.

From observations on the street and on the photographs and comparison with the contours, it appears that the extreme effective edge of the bright patch can be taken as 0.2 e.f.c. for the road explored, or about $\frac{1}{10}$ maximum brightness. Actually the streak has no sharply defined edge, the brightness diminishing continuously to a minimum of about 0.05 e.f.c. The rate of fall varies with the degree of polish; with the more matt surfaces it is not easy to say where the limit of the streak is reached. With more polished surfaces it is more clearly defined. The region between streaks, however, is not of zero brightness, and its brightness may be enhanced by suitable distribution of light. The value of 0.2 e.f.c. is chosen arbitrarily and extends probably beyond the obvious limit of the streak, but corresponds to the region over which the brightness is sufficient effectively to reveal objects.

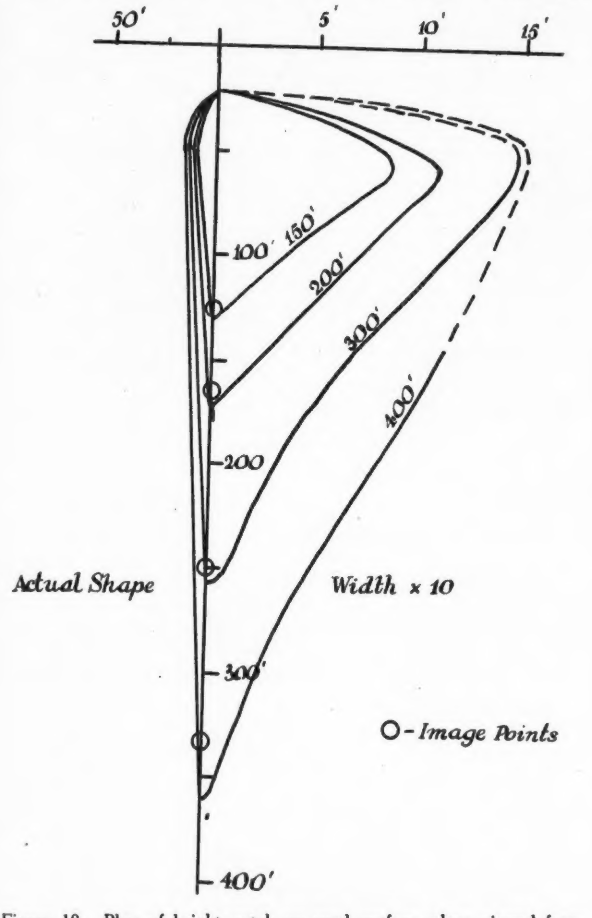


Figure 18. Plan of bright patch on road surface when viewed from different distances.

(f) Size of Actual Patch on Road.

If the 0.2 e.f.c. contour is replotted on to the plan of the road surface, it is found that in the installation measured, the patch of road which is effectively bright is of the shape shown in Figure 18. It is about 15 feet wide at about 50 feet from the post, and it tapers to nothing at about the image point or a little beyond. It does not appear to vary very much in actual width as the observer's distance from the source varies.

(g) Values of Reflectivity.

The reflectivity of the surface, calculated as the ratio of its brightness to the illumination on a small vertical face at the point concerned, has been plotted in Figure 19 in contour form to correspond with Figure 16, and in Figures 20-24 in the form of diagrams to be laid over Figure 11, for values of δ of 0°, 1°, 2°, 3°, and 4°, and, in Table 2, for the plotting of the head of the "Tee" of the streak, for three special values of δ of 15°, 30°, and 45° when $i=45°$, as explained below.

From these sheets the brightness distribution at any distance from a source having any light distribution, and at any given height, can be computed. The procedure is as follows:—

The skeleton perspective web with scales of r, ϕ_s and δ for the appropriate distance, is first drawn (as in Figure 10) by the methods given in the Appendix. One of the data sheets, Figures 20-24, is then laid over Figure 11, with its index arrow opposite to the appropriate mounting height, and the reflectivity for each value of r is found by the intersection of the appropriate D curve with the contours on the sheet.* These values are tabulated or marked on the perspective web along the δ line corresponding to the sheet used. From the polar distribution of the fitting, the illumination on a vertical surface at the corresponding points is found, and similarly tabulated. The transformation from θ, the angle on the polar curve, to r, the angle in the perspective, is performed with the aid of Figure 11. Except for points of view very close to the source, the effect of change of ϕ can generally be neglected—i.e., the illumination along any line drawn across the streak is assumed constant. By multiplying the illumination by the reflectivity, the brightness is obtained of each point, and if this process is repeated for the various values of δ and plotted on either side of the centre line on the perspective web, the distribution of brightness in the streak is built up.

This method is not convenient for the head of the "Tee," because in this region the δ lines are too cramped. The following artifice is therefore employed.

The head of the "Tee" of the streak is taken as being formed by light incident at approximately 45°, and its centre line will, therefore, be a line across the road at a distance H from the light source. This can be drawn with the help of Figure 7.†

On this line three points are marked on each side of the centre line, at distances from the centre line of 0.255 H, 0.533 H, and 0.89 H. At these points, will be approximately 15°, 30°, and 45°, and the value of ρ is given above.

These values are approximately correct for all distances between 200 and 600 feet inclusive, and all mounting heights between, say, 13 and 25 feet. If the illumination at the same points on a vertical surface facing the light source is calculated, the brightness can be found and the distribution across the head of the "Tee" of the streak will be obtained.

Table 2.

Data for calculating head of "Tee."

Position.	δ	θ	ϕ_1	ρ
0	0	45°	0	2.9
.255 H	15°	46°	$14\frac{1}{4}$°	2.2
.533 H	30°	$48\frac{1}{2}$°	28°	0.5_7
.89 H	45°	$53\frac{1}{2}$°	$41\frac{1}{2}$°	0.2_3

The corresponding values of θ and ϕ_1 are given in Table 2, in order to define the angles at which intensities are read from the distribution curves of the fitting.

* The data given in Figs. 20-24 is not quite complete and is not sufficient to cover all cases.

† Or from the formula

$$t=\frac{PQ}{D(D-H)} \qquad (2)$$

where t is the distance on the perspective of the head of the "Tee" below the foot of the post, and PQ is the perspective distance.

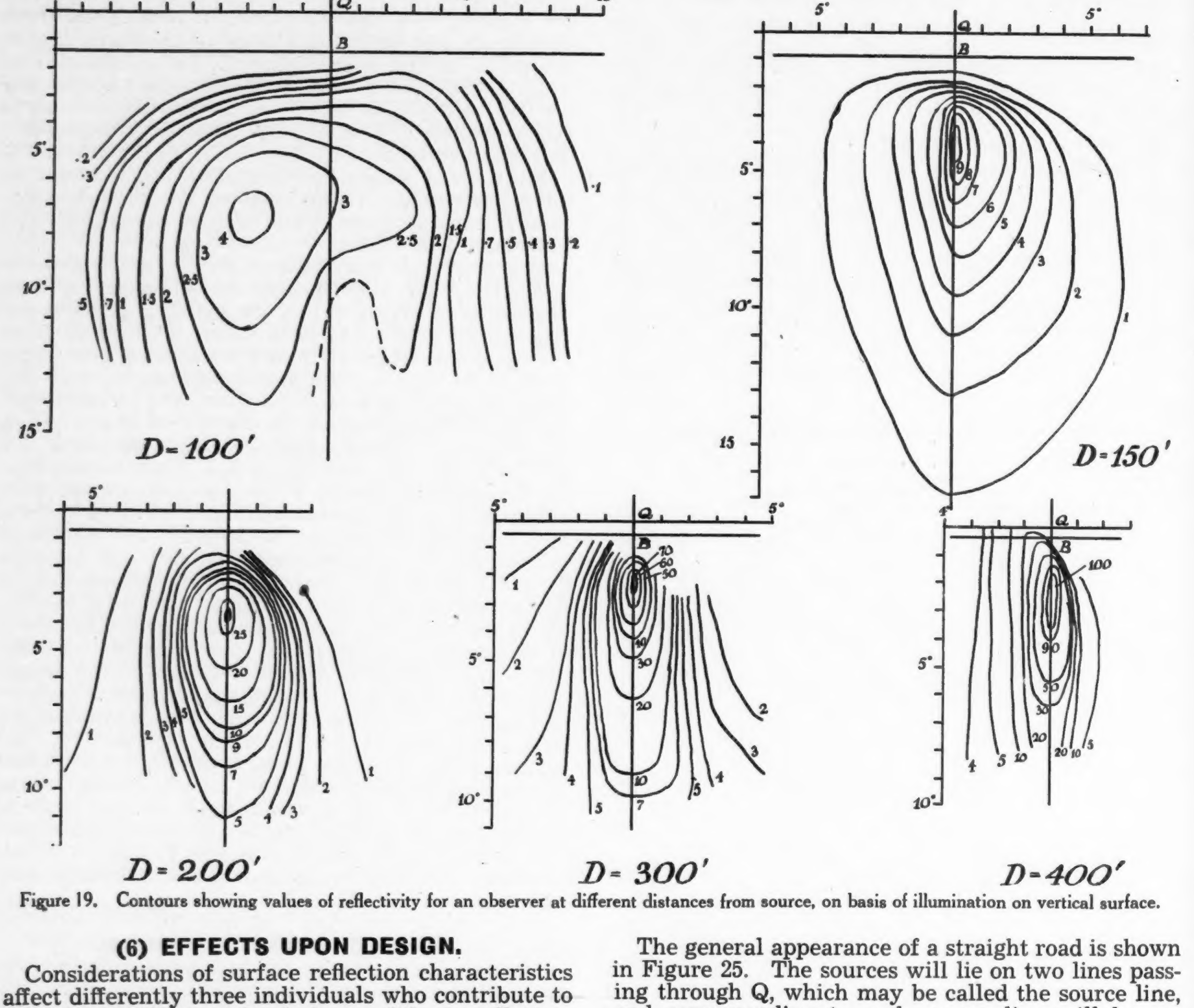


Figure 19. Contours showing values of reflectivity for an observer at different distances from source, on basis of illumination on vertical surface.

(6) EFFECTS UPON DESIGN.

Considerations of surface reflection characteristics affect differently three individuals who contribute to the final installation: the designer of the installation; the designer of equipment; and the road engineer, who provides the surface. They will be considered in that order. The designer of the installation will not wish to be involved in all the intricacy of calculations of shape and size of patches, but will desire simple rules for determining the height and location of his sources, and some guidance as to the type of equipment to select. The fittings designer will be concerned in the optimum polar distribution to produce the largest and most uniform patch with a good road surface, so that in the complete installation as large an area of the road surface as possible is effectively bright; the road engineer will wish to know what characteristics are the most helpful to the street lighting engineer and the motorist.

(a) Height of Posts.

One of the peculiar results which has been noted above (paragraph 5 (c)) is that the image point lies close to the end of the streak. Since the brightness of the streak is high, visibility is excellent over such parts of the road as are covered by them. But in other parts the brightness is generally low, and visibility is liable to be poor except when the illumination is very high, or with certain types of road surface. When the mounting height is low, or the road unduly wide, there is liable to be formed a dark zone (in the middle of the road when sources are mounted on both sides), which may constitute a danger zone. Now the size and position of the dark zone can be correlated with the height of the posts and the width of the road, and it is possible to formulate a limiting condition, which may help to ensure proper visibility.

The general appearance of a straight road is shown in Figure 25. The sources will lie on two lines passing through Q, which may be called the source line, and corresponding to each source line will be an image line QI_1, QI'_1, upon which the specular images

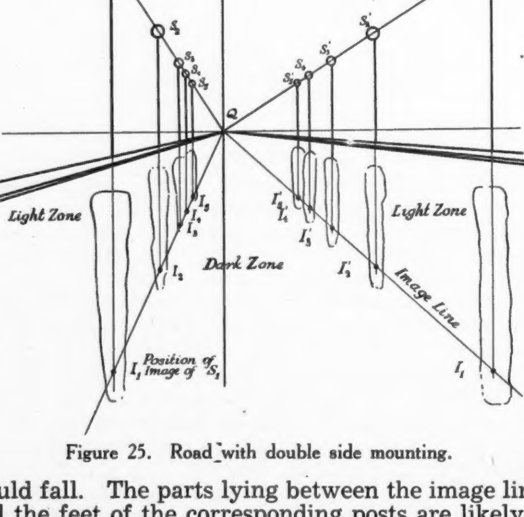


Figure 25. Road with double side mounting.

would fall. The parts lying between the image lines and the feet of the corresponding posts are likely to be bright, whereas the remainder—in Figure 26, the triangular space between the image lines—is likely to be dark. This is seen in the photograph of Figure 27. It follows that the position of the image line is important. The position of the image line will depend upon the height of the sources and the lateral

DIAGRAMS FOR USE WITH FIGURE II.

The Diagrams appearing on these two pages (Figures 20-24) were printed on transparent paper, so that they could be superimposed over Figure II. *(See Illuminating Engineer, October, 1934, page 310.)*

A few specimens of the sheets thus printed are still available and will be furnished to any reader interested.

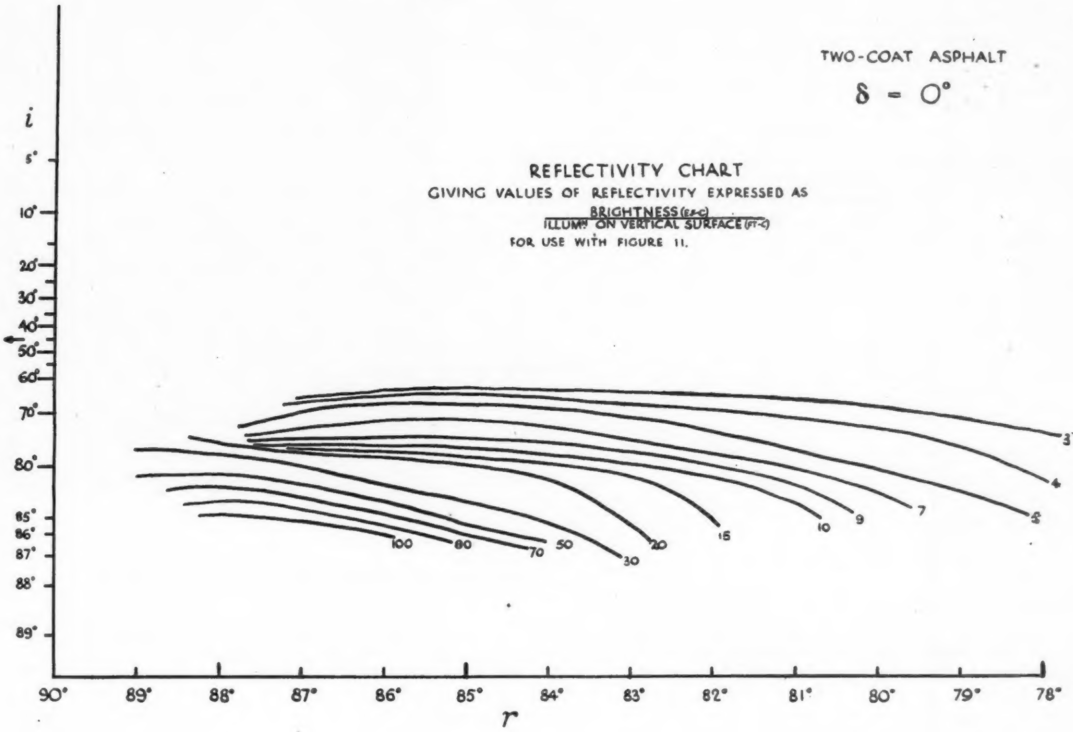


Fig. 20.

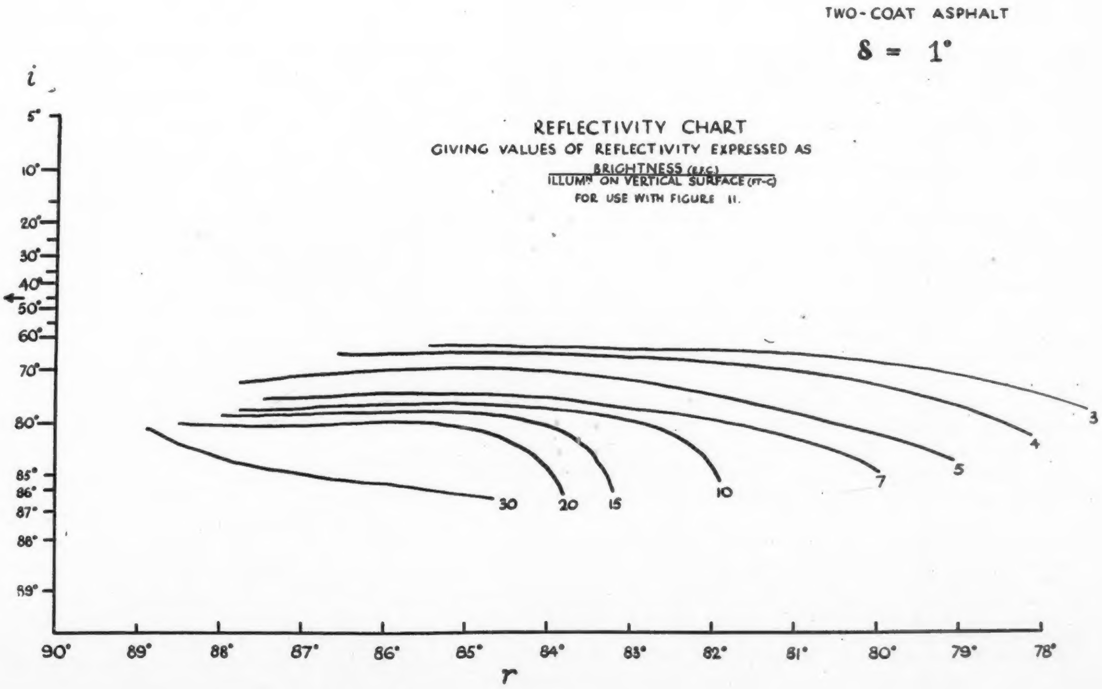


Fig. 21.

Fig. 22.

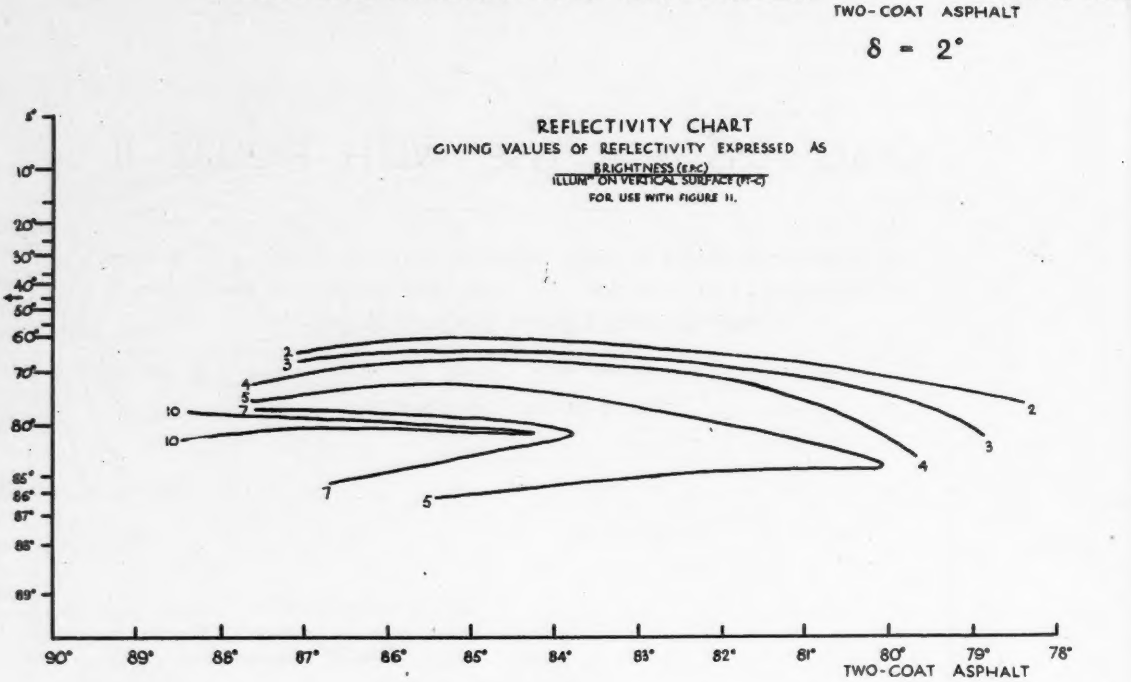


Fig. 23.

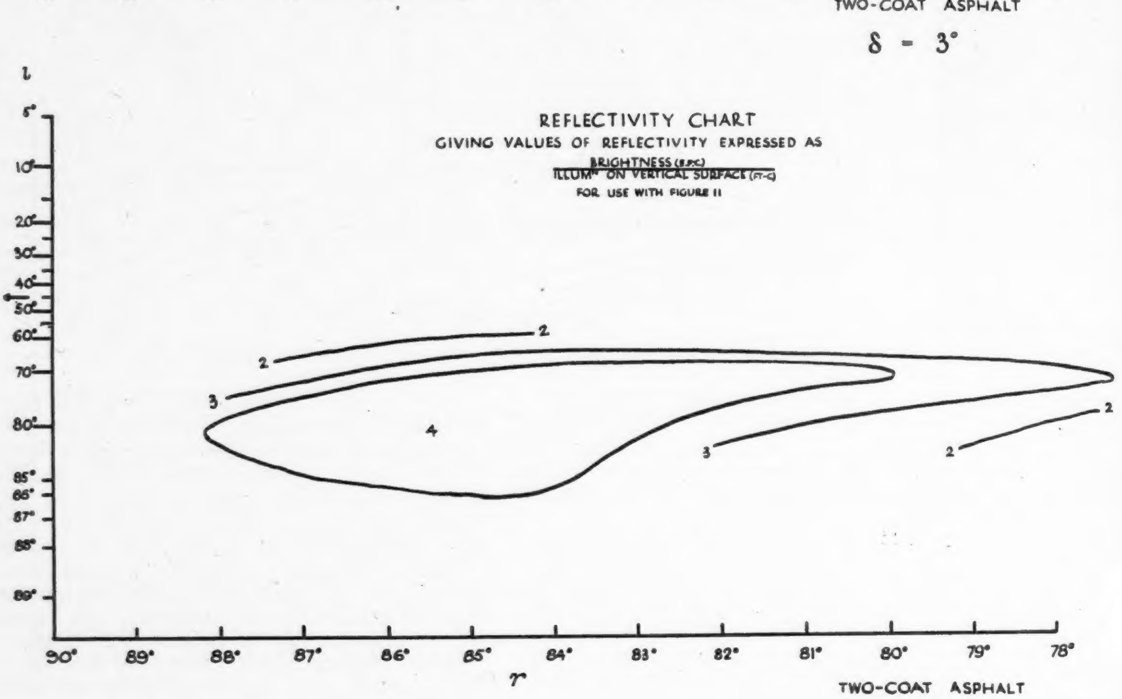
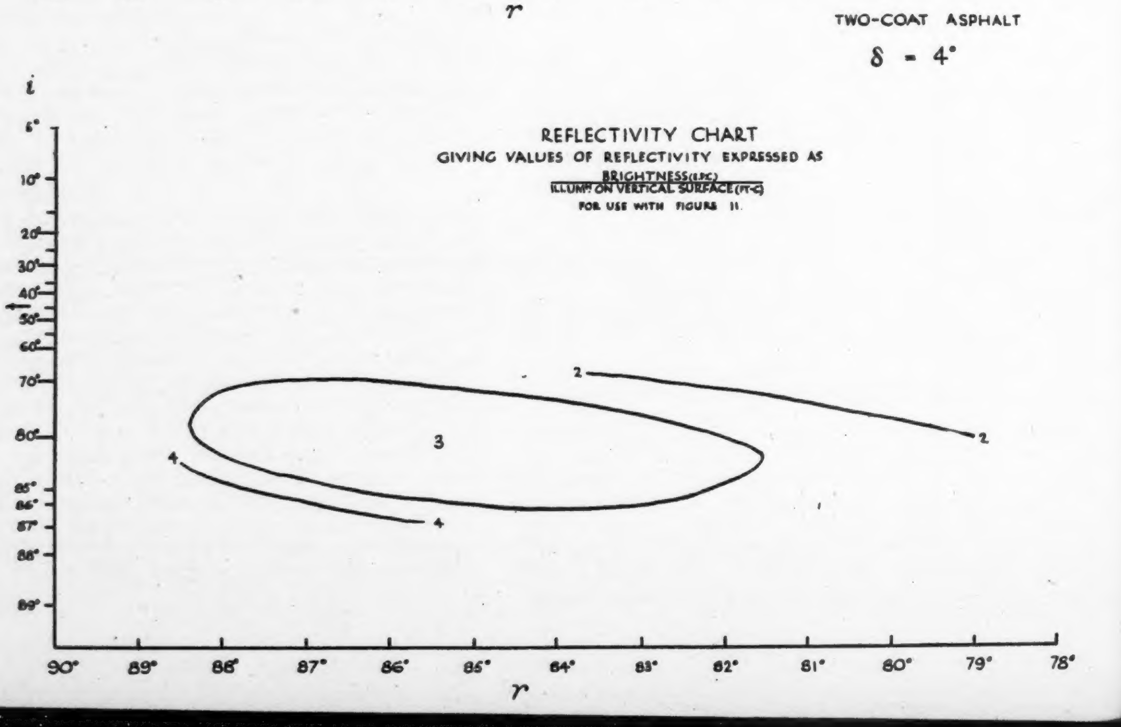


Fig. 24.



position of the observer on the road. As the mounting height increases, the source lines and image lines more nearly approach the vertical, and the triangular dark space decreases in extent. Now this

Figure 26.

triangular space in the perspective view corresponds in plan to a parallel strip of road surface; and it can easily be shown that, if the observer moves laterally in the street, the position of this strip changes, but its width remains unaltered. It can also be shown that the fraction of the road width (measured between the sources) which is likely to be rendered effectively bright, will be equal to

$$H/(H+h) \qquad (3)$$

This is an interesting result, for it appears that the

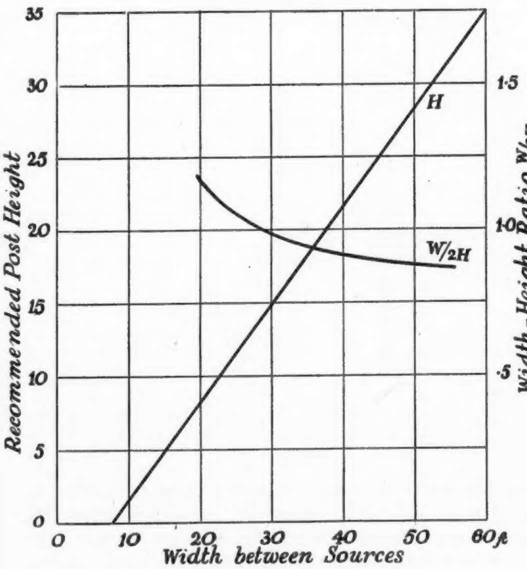


Figure 27.

proportion covered is independent of the width of the road. It is, therefore, an easy matter to find what height of post will produce, for any given width of road, a strip of given width between the image lines. The relation is

$$H=(W-W_0)\ h/W_0 \qquad (4)$$

where W is the width of the road measured between sources and W_0 is the width of the strip between image lines.

Now it is evident from what has already been shown that the streaks have a considerable width; in the case of the surface investigated, the width from the centre line varies from 0 to 15 or 20 feet, the latter width being at the part of the streak near the foot of the post. The important part in the perspective view is probably about 3-4 feet in width. This implies that if the width of the strip between the image lines is about 7 feet 6 inches, the width of the streaks will be sufficient to fill up the strip and prevent the brightness there from becoming unduly low.

Taking W_0 as 7 feet 6 inches, therefore, the necessary height of source can be worked out, giving the results of Table 3, which are plotted in Figure 28.

Table 3.

Mounting Height necessary to give a maximum strip width of 7 feet 6 inches between Image Lines, for different width between lines of sources.

Width between lines of sources.	Mounting Height.	Width-Height Ratio, W/2H.
20 feet	8.4 feet	1.2
25 „	11.7 „	1.07
30 „	15 „	1.00
35 „	18.4 „	0.95
40 „	21.6 „	0.93
45 „	25 „	0.90
50 „	28.4 „	0.88
55 „	31.8 „	0.86_5
60 „	35 „	0.86

The Table gives also the value of the width-height ratio, W/2H.*

This, it will be seen, varies slowly with the width of the road, but for ordinary widths is in the neighbourhood of 1 or slightly less. This is in accord with practical results, for a careful study made of the installations shown in Sheffield at the 1928 Conference of this Association had previously shown that a value of W/2H of 1, or thereabouts, is satisfactory from the point of view of avoidance of dark strips on the surface.

The above results apply to sources on both sides of the road. Where the sources overhang the carriageway materially there will tend to be a dark space between the line of sources (in plan) and the kerb, although the fact that this part of the road is little worn and is generally matt may increase the brightness sufficiently.

Where the sources are in the centre or on one side only, however, the above results require modification. In the first place, on a polished road surface the centrally suspended system can never render effectively bright the further half of the road; the streaks lie always in the half nearer to the observer. (See Figure 28.) Consequently, the proportion of the road covered is always less than half, and depends upon the position of the observer in the road. The road to the left of the observer is always dark (unless the road curves to the left), which constitutes a real danger, for this is precisely the region in which cyclists and slow-moving objects are found.

* The width-height ratio has been taken as the ratio to the mounting height, of that width of carriageway which can be considered as lighted by one line of sources. For sources mounted on both sides or in the centre, this width will be one-half the width between the lines of sources; while for sources mounted on one side only it will be equal to the width of the carriageway. The corresponding width-height ratios are $\frac{W}{2H}$ and $\frac{W}{H}$.

D

The proportion H/(H + *h*) given above applies only to the part between the observer and the line of sources.

The same remarks apply to single side lighting, when the above proportion applies to that part of the road between the observer and the line of sources, and therefore varies according as the sources are on the left-hand or the right-hand side. Both these systems are, therefore, at a disadvantage as compared with the systems with sources on both sides of the road; the single side system is particularly so. This latter system is often really dangerous, and it is particularly to be hoped that it will not be used in new installations except where circumstances make it unavoidable. In the author's view, single side mounting is worse than nothing at all, for it leads the driver to think that he can see without headlights when in fact he cannot.

(b) Position of Sources.

Having decided upon the height, the designer of an installation will wish to know, most of all, how he can locate his light sources to the best advantage. He will not generally be interested to undertake the

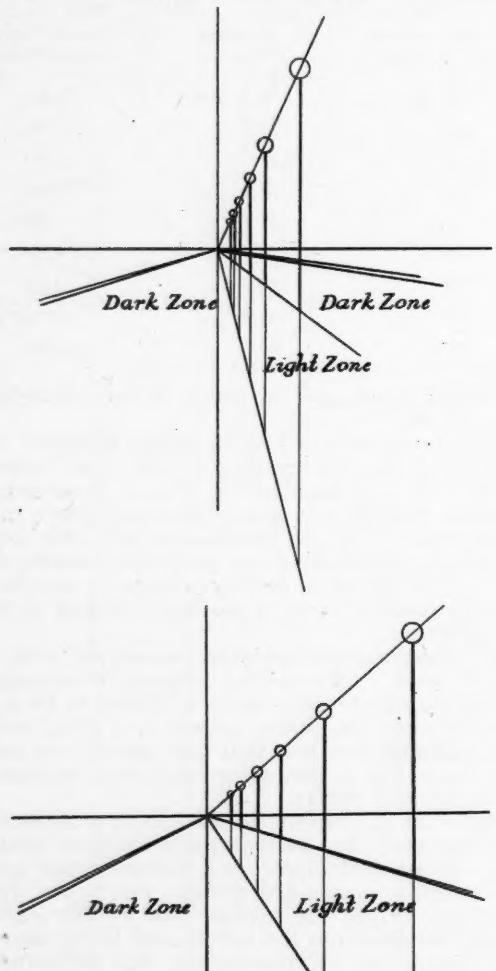


Figure 28. Roads with central and with single side mounting.

labour of calculating the size of the patch produced, for he will have to make use of standard units and light sources. It may be hoped that before long the designer of equipment will work out by the methods given and supply once for all, for this or some standard type of road surface, the size of patch on the road which any particular equipment renders effectively bright. Work on this subject is not yet complete, but it seems likely that the maximum width

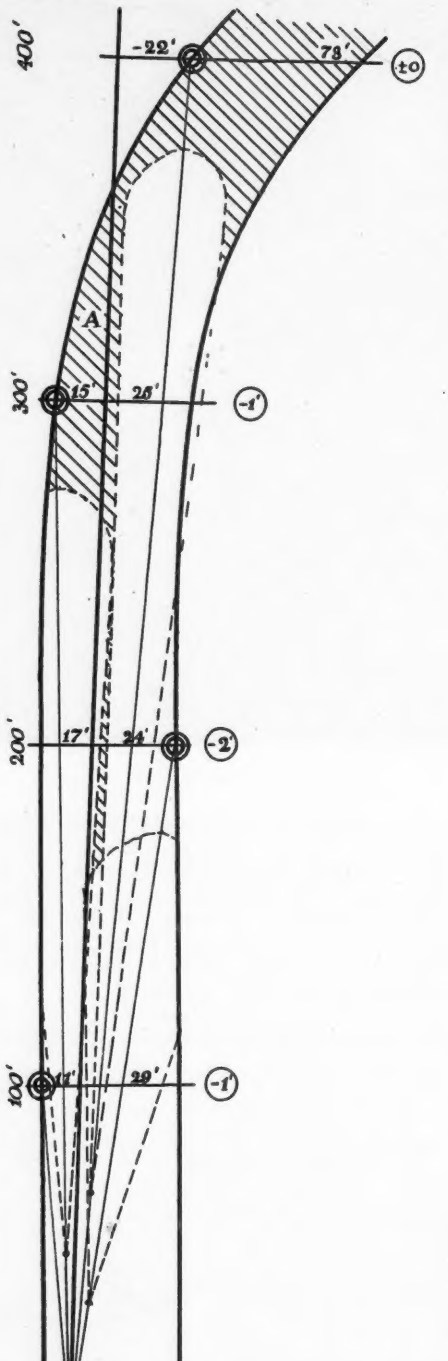


Figure 29. Plan of roadway showing bright streaks. (Figures in circles represent height of road surface in feet above (+) or below (−) level at P.)

of patch will vary slowly with change in the height of the post. The designer of the installation can do a great deal, however, if he only guesses at the size of the patch from experience, and then plots it in perspective by the simple method shown. It will, of course, be recognised that the edge of the patch is not a sharply defined line, but the brightness actually diminishes continuously from the centre line. For convenience, however, since the falling off of bright-

ness is rapid, a given brightness can be taken and designated the limit of the patch. A value of about 1-10th the maximum brightness is probably a suitable value.

Suppose, for example, that the height of the post and the lighting fitting are the same as those on which the photometry was done and to which Figure 16 refers. The size of the streak is then about 15 feet maximum width, tapering uniformly to the image point or thereabouts: the axis of the streak lies always on a line through the observer. If the trial positions of the units are decided, the patches can be set out in plan quite easily, and by inspection of the plan and trial and error, the best positions for the units can be settled approximately. At the same time a critical view point can be found, at which visibility is likely to be bad, and for this point a perspective can be drawn, including the perspective of the streaks taken from the plan, as in Figure 30. In this way the appearance of the street can be forecast fairly accurately. In Figure 29, the patches have been considered as triangular in shape, which is sufficiently accurate for the purpose of a plan. When drawing the perspective it is necessary to take the shape of the patch more exactly, for the sides are really concave. In Figure 30 the edge of the patches shown is the 0.2 e.f.c. contour. This is probably wider than the apparent width, as already stated: the bright appearance on the road would be more like the fine dotted lines shown.

It is important to consider what happens as the motorist proceeds along the road. It may be that at one position in the road a certain region about 300 feet ahead is left without bright background, and is therefore dangerous. As the motorist proceeds, the positions of the streaks will generally move, and it may be that as he approaches the dangerous region a bright streak will cross it and reveal any obstruction in good time. It is suggested that any region which may be left without bright background until the driver is within 150 feet of it is really dangerous and steps should be taken, by altering post positions if possible, to avoid the danger. The designer must, of course, consider traffic in each direction.

In the example given in Figures 29 and 30, two faults are revealed. It will be seen that the designer has wisely departed from the diagonal system in order to have the post at 400 feet on the outside of the curve, but has retained the spacing at about 100 feet. In doing so the last post is so far to the right from the point of view of a driver at P, that a region of the road marked A in both views is left dark; and if the position of the patches is studied as the driver proceeds up the road, it will be found that most of this region will continue to remain dark until the car reaches it. The region A is therefore dangerous. The perspective reveals another more subtle mistake which may easily be made. The same post having been placed on the left-hand kerb is out of order in the diagonal installation. As it is seen from P it looks—owing to the bend—exactly as though it were on the right-hand side of a straight road, and since the kerb between the third and fourth sources is likely to be dark, there is danger of a motorist failing to realise that the road curves, particularly if the view of the other posts is otherwise obstructed, or in fog, and driving into the kerb.

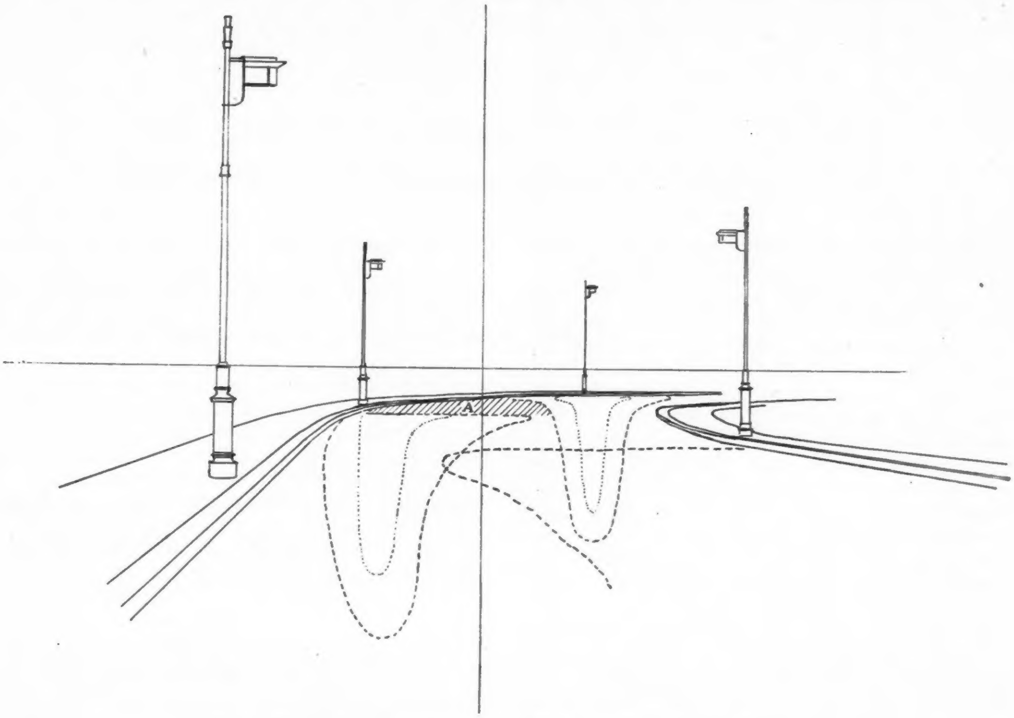


Figure 30. Perspective view of road of Figure 29, seen from P.

(c) Influence on Fittings Design.

The fittings designer wishes to have a definite basis upon which to design his distribution. Up to the present, distributions have been settled empirically, frequently by the costly process of producing a new refractor or reflector and trying it out. It has not been possible to lay down an optimum distribution upon any definite basis connected directly with road reflection properties, although certain guiding principles for the production of a smooth brightness distribution have been known.*

It is hoped that, as a result of this work, such a basis may be evolved. This has not yet been completed, but some of the desirable features of distribution may be noted.

(i) For the provision of long, useful streaks, the intensity should not be cut off above the "peak" angle of 70°-80° from the vertical, but a reasonable intensity should be provided up to 89° or 90° from the vertical. It may be necessary to reduce intensity somewhat at this region, on account of glare,

* Wilson, Illn. Engineer (London), 1933, p. 151.
Waldram: Roy. Soc. Arts J., Feb., 1934, p. 303.

but the amount of reduction has not yet been decided. It is certain that with a suitable road surface quite high values of intensity can be tolerated before the glare effects begin to outweigh the advantages of the large areas of high road brightness.

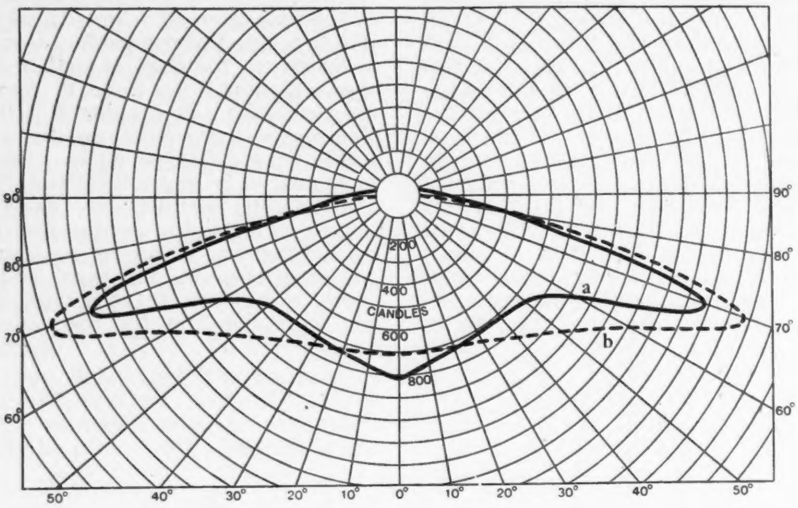


Figure 31. Polar curves of light distribution in vertical plane from old and new refractors.

(ii) It is evident that when the road surface is at all polished, the system in which light is directed only in the direction of the traffic is at a great disadvantage, for the reflectivity of the road beyond the post (when i is negative) is very low indeed, and enormous intensities would be necessary to provide anything like the same brightness as can be produced with the direction of the light reversed. The bi-asymmetric distribution, however, in which a good intensity and a wide distribution is provided against the direction of the traffic (so as to produce good wide streaks and a satisfactory brightness), and a greater intensity and narrower distribution in the direction of the traffic, has an advantage. It provides for the motorist with the wide beam, while the narrower beam illuminates the kerb and its vicinity, and is of great help to the pedestrian and cyclist, who depend less upon distant bright streaks. At the same time, the narrow beam of high intensity avoids excessive glare, since the motorist is not in this beam.

(iii) The width of the streak is determined largely by the road surface reflection properties, but the greater the intensity at regions above the peak angle, the greater will be the width of the streak. Asymmetric distributions should therefore be wide enough to provide a good intensity in all horizontal directions from which the motorist will normally be viewing the road surface. A wide " peak " to the distribution is of the greatest value, because it raises the brightness of the dark zone between streaks, particularly on the more matt surfaces. It is the dark spaces between streaks which are the danger zones, and which must be studied in order to ensure " accident proof " lighting.

(iv) It has been found by experience that a " flat bottom " polar curve, as shown in Figure 31, Curve b, has an advantage over the older " waisted " distribution (Curve a), for the older type produced a peculiar shadow across the road surface which was unpleasing. Investigations using the results obtained for reflectivity have confirmed this. The ideal curve for uniform brightness is practically " flat bottomed " from 45° upwards. Below 45°, the brightness is bound to fall off, for reasons which will be obvious from the results obtained; for the reflectivity near the post is very low, and for uniform brightness within 25 feet of the post, enormous intensities would be required. If the brightness due to the old waisted distribution is calculated, the shadow can be found either as an arrest in the curve or as a definite decrease in brightness.

The familiar polar distribution in a vertical plane can be analysed as in Figure 32, so as to demonstrate the different functions which different parts of the distribution fulfil. In the diagram the three annular zones show: (1) the regions of the curve useful to the different users of the street; (2) the contribution made by different regions of the curve to the appearance of the road and the brightness of the surface; and (3) the functions of the various parts in producing illumination on the road surface. This diagram relates to traffic in one direction only. From the point of view of appearance and visibility, only that portion from 45°, which forms the useful broad head of the " T " of the streak, up to 90°, which forms the distant streaks which help the driver, is of real value.

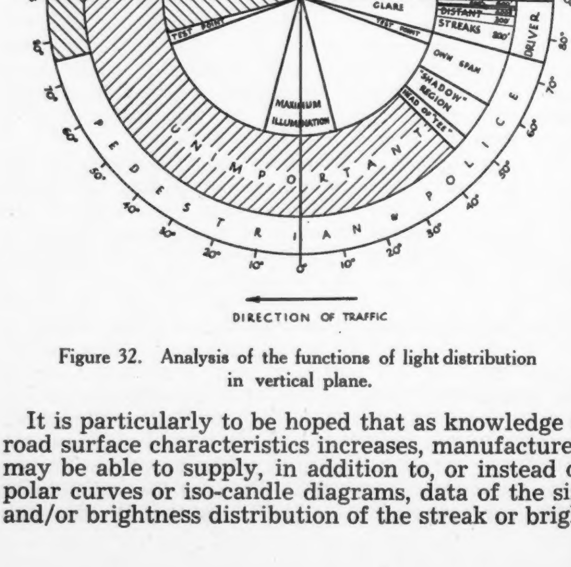


Figure 32. Analysis of the functions of light distribution in vertical plane.

It is particularly to be hoped that as knowledge of road surface characteristics increases, manufacturers may be able to supply, in addition to, or instead of, polar curves or iso-candle diagrams, data of the size and/or brightness distribution of the streak or bright

patch formed on some standard surface of known reflection characteristics. This will be a real indication of the usefulness of the unit, and might lead us eventually to some real figure of merit either for the lighting equipment or for the complete installation.

(d) Desirable Types of Road Surface.

Work has not yet progressed far enough to decide precisely what characteristics are desirable in a road surface, or how they may be obtained. It is evident from observation, however, that certain surfaces are much more helpful to the street-lighting engineer than others. It may be observed that the characteristics which favour the street-lighting engineer are precisely the reverse of those which help the motorist who relies upon headlights. The former requires a surface having a "spread" reflection characteristic in which light is reflected mostly on the side of the normal away from the light source; the motorist requires a surface which will reflect back on the side of the normal towards the light source. A road which has been tarred and sanded with light-coloured sand or gravel, or a water-bound macadam road, or a country road with a chalky surface is excellent for the motorist. The modern large-aggregate asphalt roads with a slightly polished surface are excellent for the street-lighting engineer. If such a surface is tarred and sanded, the visibility and good appearance in such a road may be ruined, and the glare from the lighting units apparently increased.

There are some asphalt surfaces which present a uniformly smooth surface and which, with wear, become very highly polished indeed and slippery. This degree of polish is unduly high and approximates to a wet road. The same surface when wet "floods" very rapidly and apparently remains covered with a film of water for some time after the rain has ceased. The larger aggregate surfaces, such as the one tested, seem to dry off rapidly and do not flood so readily—possibly owing to the presence of innumerable small indentations and channels in the surface, which seem to result from the final application of chippings. This type of surface is preferable for effective visibility from street lighting. It is probable that concrete surfaces have an advantage from their light colour, but to what extent is not yet known. In addition, they appear to possess, when worn, desirable reflection characteristics similar to those of the surface tested.

(7) CONCLUSION.

This paper is a record of progress rather than of a finished piece of work. Experiments are continuing at the time of writing, and further conclusions may have been reached before the paper is presented. Already new methods of test have suggested themselves. It is hoped that such guidance as it has been possible to obtain from the results up to the present may be of use to those engaged in the practice of street-lighting, and that the discussion will provide guidance for those engaged in laboratory work. Let us hope that we may soon reach the position of being able to measure and express in figures what we have discussed at so many Conferences, and may be able at last to plan streets as we see them. Then, according to Lord Kelvin, street-lighting may call itself a science.

APPENDIX

CONSTRUCTION OF PERSPECTIVE SCALES AND LINES OF EQUAL δ.

From Figure 9 it is seen that

$$\delta = \phi_1 + \phi_2$$

One way of plotting on plan a circle representing a given value of δ, say, $\delta = 6°$, is to set out from A and B a series of radial lines making angles with AB of $\phi_1 = 1°$, $2°$, $3°$ ... and $\phi_2 = 1°$, $2°$, $3°$ ... and to find the intersections of these two sets of lines at which $\phi_1 + \phi_2 = 6°$, e.g., $\phi_1 = 1°$, $\phi_2 = 5°$; $\phi_1 = 2°$; $\phi_2 = 4°$; etc. These points lie on the circle representing $\delta = 6°$. Other circles may be similarly constructed.

The same procedure may be adopted to find the perspective of the circle, with the difference that instead of the radial lines through A and B we use their perspective projections.

The perspectives of the radial lines through A, representing values of ϕ_2, are obviously vertical lines in the perspective, being the vertical lines of the web of Figure 6. The perspective of the set of radial lines through B, representing ϕ_1, is obtained as follows:—

In Figure 33 let B represent the foot of the post in perspective. The distance Q B will be inversely proportional to the distance of the post and may be obtained from Figure 7, or from the relation

$$QB = \frac{60 \times PQ}{D} \text{ inches}$$

PQ being the perspective distance and D the distance from the post in the same units.

First draw the vertical lines forming the scale of ϕ_2. The distance of any such line from the vertical axial line is equal to PQ tan ϕ_2. (The same values are used for the scale of d, the angle of depression, represented by horizontal lines.) The lines representing ϕ_1 in the perspective are found by joining B to the intersection with the horizon line of the ϕ_2 line of the same value: e.g., for $\phi_1 = 4°$ join B to the point on the horizon line where $\phi_2 = 4°$.

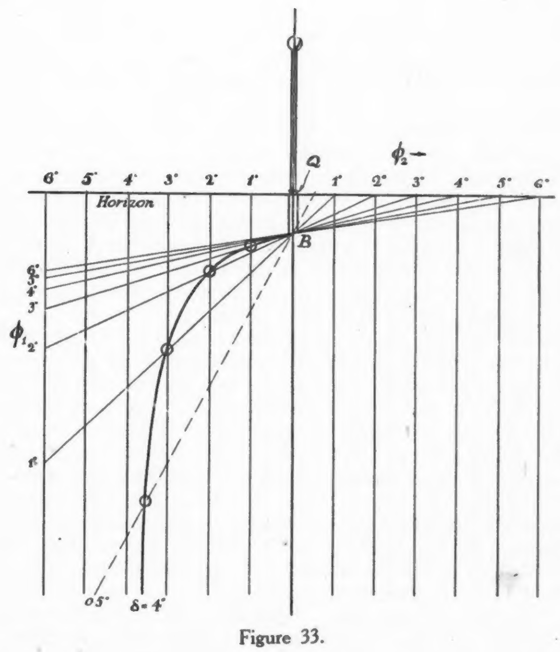


Figure 33.

Having now the two series of lines representing ϕ_1 and ϕ_2 it is easy to find the lines corresponding to $\delta = 1°$, $2°$ ... from their intersections, as in the corresponding circles in plan.

Road Surface Reflection Characteristics and their Influence on Street Lighting Practice (Discussion)

Major L. ROSEVEARE (Eastbourne), who also represented the Institution of Municipal and County Engineers, said that the paper was an essentially practical one which would lead street lighting engineers and those responsible for street lighting to re-orientate, if not revolutionise, their whole ideas on the art of street lighting. The paper threw new light on the question from the motorist's point of view, and this one paper alone was well worth coming all the way to Aberdeen to hear. The matter of perspective and also of brightness of the road, as set out by the author, constituted a definite alteration of the whole basis of street lighting as hitherto conceived; and in view of what had been said of the effect of bright and matt surfaces of roads, it was up to road engineers to try and get something intermediate between a bright and a matt surface. An endeavour should be made to obtain a standard type of road surface of a matt nature so that lighting engineers and the makers of lamps would be able to work to a more or less standardised road surface.

Mr. W. J. JONES (London) said the paper must be recognised as another milestone towards the goal of obtaining some measure of visibility along a street. For years we had been content to measure solely illumination, but the author had now shown the importance of brightness in obtaining some measure of performance. Personally, he believed we should go still further and prescribe a degree of visibility, according to the nature of the thoroughfare. It was impossible not to be greatly intrigued with the delightful technique employed by Mr. Waldram in dealing with this question of brightness, and he would be serving not only the public, but also the technicians engaged in this work if he carried his experiments still further, not only to include the brightness along the thoroughfare but also to include the contrast afforded along a thoroughfare by the various kinds of objects, an aspect of the problem which was of equal importance with brightness. There was another matter of fundamental importance in connection with what might be termed straight roads. It was exceedingly difficult to obtain a long vista down a road, and if we were not careful we should overemphasise the brightness contrast against the road surface, because in many instances the contrast was against the lighted background of a building or some screen at the end of the road. Incidentally, he suggested the use of something in the nature of cricket screen at sharp bends in roads, which would automatically compensate for some of the difficulties to which reference had been made in the paper. For example, if there were an individual or an on-coming vehicle, say 200 yards away, and there were a bend in the road twenty or thirty yards beyond, the individual or vehicle was silhouetted against the road to a height of about only 2 feet, the rest being silhouetted against the background, if any. That also applied to cyclists. Therefore, it was important to bear in mind the value of illuminated backgrounds if the whole problem of contrast was to be treated in a complete manner. Finally, Mr. Jones asked whether the author considered that the question of specular reflection from a road surface was of vital importance to all roads, or whether he considered it only of importance in the case of arterial roads or long roads where the light sources were, perhaps, 200 or 300 ft. apart. In these roads it might be possible to obtain equally satisfactory results by closer spacing and using a road surface which had greater diffusing properties.

Mr. F. C. SMITH (London) also thanked the author for having made a real contribution to the science of street lighting, and agreed with the views he had put forward. If we could get down to the author's perspective treatment in dealing with street lighting we should have gone a long way towards solving our problems. Mr. Smith said that he had been trying to put himself in the position of the municipal engineers, and it seemed to him that several other matters required careful attention. For instance, the road must be of lasting material and have a surface which would prevent skidding, as far as possible. The municipal engineer, too, was restricted in the choice of materials. For instance, there were roads in the Midlands which had a red surface, whilst in the Aberdeen district the surfaces were granite setts; and the question of economics suggested that the engineer would use the material which was to hand locally. No doubt the author would reply that it was possible to make use of road dressings in order to obtain something approaching a standard surface. An obvious point, which he hesitated to put forward, was the change of reflection properties of various road surfaces under different conditions. After a road had been in use for some time the surface tended to become polished, although it was matt to begin with; and on a worn surface there might be true specular reflection in wet weather. All these things made the putting into practice of some of the ideas put forward in the paper a little difficult, but we should not refrain from trying them on that account and making a real attempt to understand the problem. Nevertheless, it was not all such plain sailing as the delightful explanation of the author might lead one to think. Finally, Mr. Smith agreed with Mr. Jones in the view that contrast is of fundamental importance, and of more importance than surface brightness.

Mr. E. L. DAMANT (London) said that the attempt to produce visibility of objects by silhouette had sometimes been criticised as being an unnatural method, different from the method by which objects are seen by day. Street lighting engineers were said to have adopted it because they could do no better. In order to test this charge he had had himself photographed while crossing an asphalt street, first from an upper window, looking down on the street, and then from the level of the road. Mr. Damant showed slides of the two photographs. In the first he appeared, as might be expected, as a light object on a darker background; but in the second, the brightness of the road surface had so increased that he appeared in silhoutte against it. Evidently the method of seeing by silhouette occurred by day as well as by night.

Mr. A. M. BELL (Tottenham) spoke of the dangerous condition of the roads just about lighting-up time. He had travelled from London to Aberdeen by road in daylight without once sounding his horn. If the sounding of horns was to be prohibited at all times—as had been suggested—then improvements in street lighting were essential, and the ideas expressed in the paper came into prominence.

Mr. C. C. PATERSON (London) said he thought it had long been accepted as an axiom that in street lighting one saw objects as dark on a light background and unless we were clear on that point, which was fundamental to everything, we should be rather uncertain as to the advice to be given to those who looked for guidance on this matter. An important conclusion to be drawn from the paper was that more attention must be paid to the value of light given out at those angles which had hitherto been regarded as productive of glare. The avoidance of glare was an old tradition which we had been trying to support—and rightly so—but it came from a time when we did not look upon roads so much from the motorists point of view as we did now. The fact that, as the author had shown, the brightness of streets, owing to the glancing incidence of light on the road, was so valuable and enhanced the brightness at dis-

tances of 400 feet to 600 feet from the source, seemed to necessitate reviewing that old tradition and seeing whether we were not sacrificing good visibility for the sake of what we feared in glare. The point that some people were inclined to forget was that glare is not produced just by the amount of light coming to the eye from the source. That was only half the story. The other half of the story was the brilliance of contrast of the object that was seen, and it was possible to put up with a great deal of light in the eye from the source if the contrast which one had to look at was high enough. The author's point was that in enhancing these streaks of light, one was at the same time putting up the brightness of the road and the contrast was being increased in even greater proportion than the dazzle from the source was being increased. Therefore, he hoped that before jumping at conclusions on this matter, the position would be looked at carefully because he personally was beginning to be very much convinced that there was a lot in what Mr. Waldram had said. In conclusion, Mr. Paterson referred to what had been said concerning the relative value of road surfaces having different colours, and suggested that this was not so important as was imagined; because with the light coming on to the road at a glancing angle the tendency would be for the road, whatever its colour, to reflect the colour of the light. What would affect the amount of brightness would be the roughness of the surface.

Mr. H. S. Allpress (Birmingham) showed a slide of a photograph taken on a section of road in his district where there are centrally suspended lamps and claimed that the excellent results obtained were an answer to the challenge thrown out in the paper with regard to the use of centrally suspended lamps. In the instance he had illustrated, Mr. Allpress claimed there was high brightness along the centre of the road and a continuous bright streak in front of the motorist. The photograph was taken in front of a motor car standing at rest in the curb, and the road, it was stated, was wide enough to take four lines of traffic.

In the course of the discussion the Hon. Secretary presented a written contribution from Mr. L. T. Minchin who, after pointing out the limitations of the isolux method in relation to brightness, analysed the curious "tadpole-shaped" streak so often observed on semi-mat reflecting surfaces. This consisted of a "tail" due to scattered reflection and a "head," from which light at an angle of reflection much further from the angle of incidence reached the eye. On a wet road the "tail" predominated whilst a more mat surface and a high diversity of illumination favoured the "head." It appeared that a slight lengthening of the streak could not materially improve the brightness of the darker parts of the road. The brightness streaks required widening rather than lengthening in order to remove danger spots—a procedure most readily effected by increasing the height of the lamps; however, good results could be obtained even with quite low mounting heights provided that an occasional refuge lamp was employed to "fill up" the centre of the road.

The Author in reply to the discussion thanked the speakers, and in particular Major Roseveare, for the way in which his paper had been received. He hoped that road engineers and street lighting engineers would co-operate and would each contribute to a proper solution to the problem. He had hoped to be able to do some work on contrast as mentioned by Mr. Jones. A dangerous condition was reached when the object was lighter than the road, and therefore the brightness of the object would have to be considered. With a well-designed system, however, the road surface could be made so bright that the object brightness was unimportant. Before cricket screens could be used on corners, there would be many interests which would have to be satisfied; but he had often noted that where advertisement hoardings were erected and carried light coloured advertisements they were useful in producing a good visibility. In reply to Mr. Jones' third question he considered that due account should always be taken of the road surface in any installation, and road surfaces having any wear were generally more or less polished. Mr. Waldram said the only real mat surface he had ever seen was on a promenade at Lowestoft where all vehicular traffic was excluded. Normally, although a road started with a mat surface it soon became polished. Close spacing was always an advantage provided that the mounting light was sufficient for the road width, but it was unwise to rely on a road with "more diffusing properties." In regard to the photograph shown by Mr. Allpress of central lighting, he suggested that a part of the effect had really been obtained by photographing a part of the road which ran up hill in the direction in which the photograph was taken. In a centrally-lighted road the kerb always tended to be dark, though if the illumination were high enough the kerb was not dangerously dark. Moreover, the effect as seen from a motor car in the kerb was not the same as seen from a car moving along normally, say ten feet away from the kerb. Nevertheless, the result was an excellent one. The point mentioned by Mr. Smith as to varying road surfaces emphasised the need for co-operation between the lighting engineer and the road engineer, and it was to be hoped in that way that some standard surface would be obtained upon which calculations could be based. He particularly valued Mr. Damant's contribution, and the excellent demonstration which he had given of an unexpected fact.

Mr. Paterson had drawn attention to the old problem of glare. There were two schools of thought in street lighting: one sought to improve visibility by removing all glare, using a cut off, and the other introduced a certain amount of glare which was of no consequence because contrasts were intense and surface brightness high. In his view the second system, advocated in the paper, was superior. In the first system the eye was so sensitive that it was a prey even to a motor car sidelight, which became a serious glare source: but in the latter system even a headlight generally made little difference to one's ability to see.

In regard to Mr. Minchin's observations he agreed that illumination values would probably always be of use in street lighting, but he doubted whether the isolux diagram was of much service, as the amount of real information furnished was so small in comparison with the labour involved. He also doubted whether bright patches could generally be dissected into a separate "head" and "tail" in the manner suggested. Although their relative properties changed with the degree of polish the formation of bright spots was not so simple as this analysis suggested. The most obvious need was doubtless an increase in width of streak, but in many cases an increase in length was equally valuable. High intensity near the horizontal had the value of both lengthening and widening the streak, besides increasing its brightness. It was true, as Mr. Minchin remarked that an increase in height increased the width of the streak—but if the intensity were cut off near the horizontal there would be very little streak to widen. Central lamps, in addition to side-mounted lamps, did have a useful "filling up" effect, but their use was only justified on exceptionally wide roads. On ordinary roads, he suggested, the main installation should be sufficient to render the whole surface bright without help from refuge posts which, in their attempt to reveal obstructions, were liable to become dangerous obstructions themselves.

ERRATA.

Our attention has been drawn to the following errata in the reproduction of Mr. J. M. Waldram's paper in the October issue:—

Page 307. 4 lines below Fig. 5, for "$\frac{1}{d}$" read "$\frac{1}{D}$."

" 311. Col. 1, 11 lines above Fig. 12, for "laid over Figure 10," read "laid over Fig. 11."

Some New Forms of Street Lighting Fittings

By

S. ENGLISH, D.Sc., F.I.C., F.Inst.P.

Paper presented at the Eleventh Annual Meeting and Conference of the Association of Public Lighting Engineers, held in Aberdeen during September 17th to 20th, 1934.

INTRODUCTION.

The British Standard Specification for Street Lighting of 1931 was directly responsible for the presentation to this Society in the following year of two excellent papers by Mr. Smith and Mr. Wilson, dealing with the planning of street-lighting installations to conform with the recommendations of that specification. These papers were complementary to the specification, and showed how it worked out in practice. In very much the same way, though not entirely so, the present paper is the direct outcome of a paper on electric discharge lamps presented to this Society at its Conference at Margate last year. Up to about that time, electric discharge lamps did not enjoy unrestricted sale, and consequently manufacturers of lighting fittings generally had not designed special fittings for use with these lamps, but with the extended manufacture of such lamps and their consequent general sale, fittings manufacturers have provided a varied and interesting range of fittings specially designed for lamps of this type. To the extent that the present paper deals with these fittings it is complementary to the paper presented by Mr. Wilson last year, and shows how discharge lamps are being housed in practice.

The development of new fittings directly caused by the introduction of electric discharge lamps has not reduced development in the older fields to a standstill; but, on the contrary, it appears to have induced and accelerated activity in some other branches—more particularly in the design of gas street-lighting fittings. In view of this remarkable activity in the design of new street-lighting fittings both at home and on the Continent, it has been necessary, in order to keep this paper within reasonable limits, to exclude all developments which were known (even though in experimental form) at the time of the Margate Conference, and also to exclude all developments which are merely extensions or modifications of ranges of fittings that were known or introduced at that conference. Despite these exclusions, we are left with at least one interesting development in connection with gas street lighting, at least one dealing with filament lamp street lighting fittings, many and various types of fittings for use with mercury and sodium electric discharge lamps, and similar developments in France and Germany. Unfortunately, so far as it appears at present, there is nothing to report from America.

Before beginning the paper proper, there are two explanations I would like to make. First, it may appear, in what follows, prismatic glass refractors of various kinds occur somewhat frequently. This, I should explain, is not to be attributed to the fact that I am concerned with the design of such refractors. It is merely a consequence of the fact that fittings manufacturers who have never before used prismatic glass are now turning to it.

Secondly, the paper only deals with street-lighting equipment, and not with actual installations of the units described, consequently there are included no data from actual installations, nor any photographs illustrating them. Such photographs are indeed sometimes apt to be misleading, as the nature of the road surface often has more influence on its appearance in a photograph than the illumination on that surface.

NEW GAS STREET LIGHTING FITTINGS.

One of the most remarkable features of our progress in street lighting is the energetic and progressive outlook displayed by some of our largest gas companies and gas-fittings manufacturers during recent years towards the problems involved. The principles adopted in the British Standard Specification for street lighting have been regarded as favourable to electric lighting, because of the ease with which directive apparatus can be used with electricity and the comparative difficulty of using such appliances with the larger sources, such as are found in multi-mantle gas burners. At the Conference last year, there were, however, on view in Margate quite a number of reflectors and refractors of various types, each showing how designers had attempted to redirect some of the light given by the mantles towards the area of roadway lying in between posts. In several cases developments along the lines demonstrated at Margate have proceeded during the intervening year, but such developments cannot receive here anything more than this passing notice.

Partly as a result of the Margate demonstrations, it was felt by certain members of the Gas Light and Coke Company that, though the equipment on view there showed good results so far as the roadway lighting was concerned, it was not all that could be desired. For example, it must be admitted that, in general, the improved light distribution was attained by attachments to standard lanterns, which definitely looked like additions, which did not always harmonise with the lines of the lanterns. It was felt that it would be better—from the practical as well as the psychological point of view—to design an entirely new lantern, keeping in mind from the beginning that it should have fairly strongly marked directive properties, so as to give reasonably uniform road surface illumination when installed under normal conditions. The acceptance of this conclusion facilitated a second decision—in regard to the burner. It is generally admitted that the circular arrangement of gas mantles is the best method of grouping from the point of view of total light output, but the size and shape of such a source and the type of light distribution from such clusters are not such as can be dealt with very effectively by redirecting devices built in as part of the lantern. It was therefore decided to adopt an arrangement of mantles in line or slightly staggered. On this basis a refractor of heat-resisting glass, in the form of a built-up elongated bowl was designed, and the Gas Light and Coke Company's staff designed and produced a new type of lantern to carry this glassware.

After preliminary trials had shown sufficient promise, selected lantern manufacturers were invited to co-operate by pooling their ideas and producing a standard lantern following the lines of the original Gas Light and Coke Co. model. The general lines of this lantern are shown in Fig. 1 (a and b) which also gives an indication of the way in which the light from the line source of mantles is redirected. It is clear from these diagrams that the upwardly and horizontally emitted light from the mantles is refracted and redirected into a path about 15° below the horizontal. The light emitted below the horizontal is less strongly refracted and is to a certain extent diffused by means of prisms with curved faces. The centre panels may have smooth surfaces on the inside as indicated in

Fig. 1 (a) thus producing axial directional effects, such as are required for central mounting or for relatively narrow streets at wide spacings, or they may be had with vertical redirecting prisms giving a 10° bias to the main beam such as is required for ordinary side street mounting. An isocandle diagram derived from measurements on one of the early lanterns using axial glass panels is given in Fig 2. The lantern had eight bijou mantles slightly staggered and had a gas

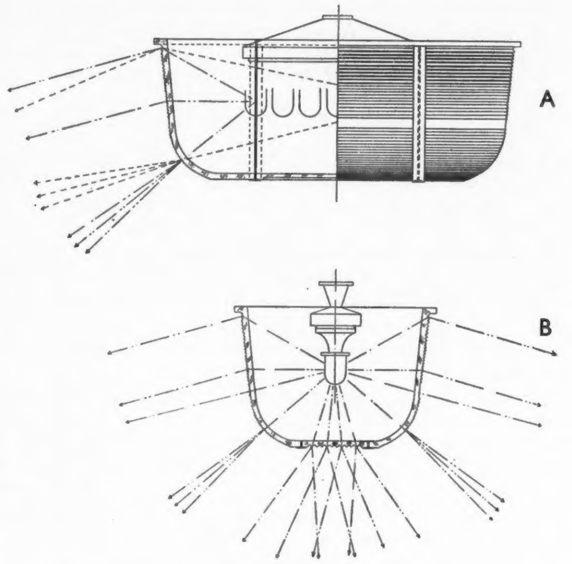


Figure 1. Prismatic Glass for Linear Gas Mantles.

consumption of 16.18 cubic feet per hour. The diagram indicates that the lantern produced a fan-shaped beam with a maximum intensity of 1735 c.p. at 75° from the vertical. The re-entrant portions of the 300 and 400 c.p. contours have since been smoothed out. With such a strongly marked maximum on the candle power curve it is feasible to space out these lanterns wider than it is safe to do with lanterns with less strongly marked light redirecting characteristics, as shown by the following data.

TABLE I.

SPACING AND GAS CONSUMPTION FOR CLASS E AND F STREETS.

Class of Street.	Mounting Height. (Feet)	Spacing. (Feet)	Spacing/Height Ratio.	Gas used per hour per 1,000 sq. ft. of roadway.
E.	21	121	approx. 5 : 1	3.3 cu. ft.
F.	18	141	approx. 8 : 1	2.8 cu. ft.

When it is remembered that wide spacing and low gas consumption both represent economy in use, it will be seen that these figures are encouraging.

In order to show the light distribution along a typical roadway more clearly, an isolux diagram is shown in Fig. 3. For the purpose of this diagram the following assumptions have been made: Mounting height, 20 feet; overhang, 6 feet; width of roadway between curbs, 40 feet; width of footpaths, 10 feet, making a total road width of 60 feet. One rather interesting feature of this diagram is the way in which the isolux lines run practically parallel with the curb on the side of the road away from the lamp, thus indicating a very uniform illumination all the way up that side of the road.

A trial installation of six of these lamps has been arranged in London, and a few are on view in the streets of Aberdeen during the period of the Conference, but it is too early yet to come to any conclusions concerning them. It is probable that with further experience with this new lantern, it will be possible to improve on the present performance, perhaps by obtaining an improvement in the general performance of the lantern, and perhaps by some modification of the light distributing prisms on the glassware.

On the continent the latest developments in gas street lighting appear to be extensions of ideas that

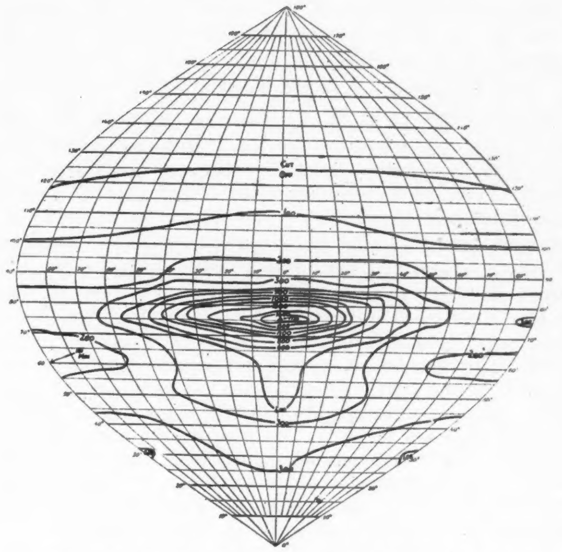


Figure 2. Iso-Foot-Candle Diagram for Unit shown in Figure 1.

have been in use here for some considerable time. In the first place there is a new type of pear-shaped globe which carries the idea of our half-frosted globe a stage further than we have gone. This new globe has the shape of an elongated pear, and consists entirely of diffusing glass, but for a narrow ring of clear glass near the top. As a result of this construction all the light emitted from the burner is diffused except that which is emitted in the neighbourhood of the 75° angle, and a very nicely shaped polar curve is produced. Unfortunately, however, the polar curve of the light distribution of the bare source is not given, so for comparison purposes, the corresponding curve of a British 6-mantle lamp has been recalculated to Hefner candles. This comparison indicates quite clearly that the attractive shape of the polar curve given by the new globe has been obtained by

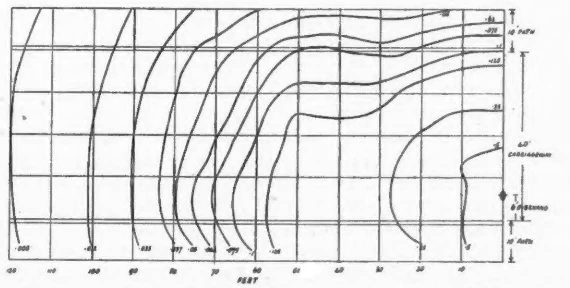


Figure 3. Isolux (Foot-Candles) for One Lamp (160°) as Figure 1. 40 Feet Carriage Way. 6 Feet Overhang.

a very heavy light absorption, since the British " bare lamp curve " everywhere lies outside the curve given by the German lamp with its special globe.

The second interesting idea that is being developed in Germany is the use of a silvered glass, elliptical reflector, in the form of a tilted dome. This is only suitable for lanterns carrying up to 4 mantles. From its contour it is obvious that with single or small clusters of mantles it will be fairly effective in

spreading the light up to about 70° from the foot of the post, but the light will be strictly localised to the length of roadway covered by this angle. This latter is a feature which is not in favour in this country.

ELECTRIC FILAMENT LAMP STREET LIGHTING.

Entirely new lines of development in connection with the use of electric filament lamps for street lighting purposes are naturally almost conspicuous by their absence, since practically every designer of electric street lighting fittings has, during the last twelve months or more, been occupied on work connected with electric discharge lamps, but there are, at any rate, two items that seem worthy of a short consideration.

Towards the end of May (1934) I had the pleasure of being present at an official demonstration of new street lighting equipment on an experimental road in the Bois de Vincennes on the outskirts of Paris. On one particular section of this road, filament lamps were being used in silvered glass reflectors, the new feature of the system being that the glass of the lamp bulb was a pronounced yellow colour. The reason for this appears to lie in the preference many motorists have for yellow headlights, which are supposed to give an increased fog or mist penetration, an increased visibility and a reduced glare effect as compared with ordinary white head-light lamps.

These valuable characteristics appear to have been confirmed to the satisfaction of certain lamp makers, and they have then carried the argument a stage further by saying that if a yellow head lamp is good for the motorist for these reasons, then a similar yellow lamp should be good for motor road lighting and for street lighting generally. The effect on the stretch of experimental roadway served by these yellow lamps was not unpleasant, but the results produced by 500 watt lamps at a spacing of less than 100 feet on a light coloured concrete road surface were not quite up to expectations.

In our own country, the development it is desired to mention concerns a fitting for use with filament lamps. It cannot be gainsaid that consequent on the adoption of higher mounting heights and closer spacings for town street lighting that have been encouraged by the British Standard Specification, the dome type of refractor is giving very satisfactory results, but there are occasions when a rather wider spread of light, or a rather more even illumination than can be obtained with dome refractors is necessary. For such occasions, it is very convenient to be able to use an attachment to a standard dome refractor so as to convert it into a virtual bowl type of refractor. This has been done by providing a dish with internal prisms of lenticular formation designed to fit under a dome refractor and convert it into an enclosed unit (Fig. 4). Naturally, the prism formation on the dish is such as to take the light that is emitted symmetrically downwards by the lamp and spread it out into two broad beams either at 180° or at 150° to each other. These beams strike the roadway at such angles as to reduce the illumination in the neighbourhood of the foot of the post and gradually build it up at more distant points. This is shown in tabular form in Table 2, which indicates the foot-candle illumination to be expected at points at the corners of five feet squares covering the roadway when one combined dome and dish refractor is used with a 300-watt lamp mounted twenty feet above the road surface.

This table shows that from one unit the illumination near the middle of a 30-foot road at a distance down the road from the foot of the post of seventy feet is 0.1 foot-candles, while at the opposite curb at this distance, the illumination is 0.075 foot-candles. If two units were mounted 140 feet apart and on the same side of the road, the test point reading would therefore be 0.15 f.c. The reading at the same position down the road, but on the same curb as that in which the lamps are mounted would be 0.134 foot-candles. This would be the minimum reading and since the maximum reading is 0.76 foot-candles near the foot of the post, the diversity ratio is rather less than 6 to 1.

TABLE 2

ILLUMINATION FROM UNIT SHOWN IN FIGURE 4
MOUNTING HEIGHT 20 FEET — LAMP 300 W

	70		60		50		40		30		20		10		0	FEET
	·067	·085	·10	·12	·15	·21	·24	·22	·26	·38	·45	·59	·61	·76	·57 (UNIT HERE)	0
	·080	·088	·10	·13	·15	·19	·27	·32	·25	·35	·37	·57	·55	·49	·49	5
	·093	·097	·098	·11	·14	·17	·23	·38	·26	·30	·32	·46	·47	·39	·38	10
	·10	·10	·096	·097	·13	·16	·19	·28	·23	·25	·24	·31	·30	·28	·29	15
	·10	·095	·094	·094	·12	·14	·17	·22	·17	·20	·18	·21	·20	·21	·21	20
	·094	·090	·090	·092	·11	·11	·14	·16	·13	·15	·15	·15	·18	·14	·14	25
	·075	·073	·070	·072	·077	·091	·12	·10	·10	·10	·11	·11	·10	·10	·10	30
	·065	·044	·048	·051	·064	·081	·084	·068	·072	·071	·072	·072	·072	·072	·072	35

By the use of suitable factors this method of setting out results is capable of indicating what readings might be expected when the same fitting is used with different lamps and at different mounting heights, and is in the opinion of many people a most useful and intelligible way of setting out the performance of a street lighting unit.

ELECTRIC DISCHARGE LAMP STREET LIGHTING EQUIPMENT.

The advent of electric discharge lamps and their adoption for street lighting purposes have set equipment designers an entirely new set of problems to solve, and as might be expected during the initial period, there are quite a large number of new ideas being tried out to see how far they solve the problems set by the lamp itself. Among these ideas that are being tried out we have some that are quite novel, and others that are adaptations of previous

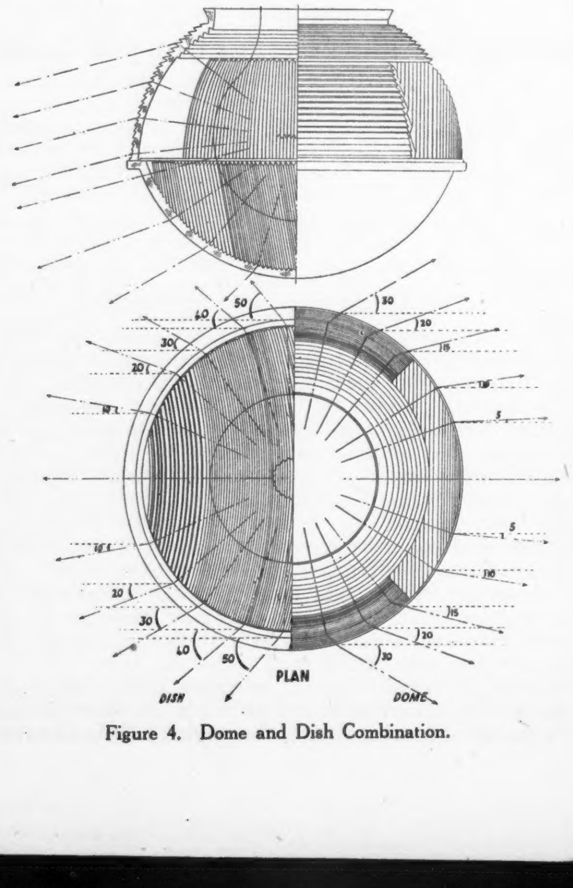


Figure 4. Dome and Dish Combination.

practice; some that assume that the discharge lamp as we know it is in a fairly stabilised form, and others that seem to be prepared for changes in the form of the lamp.

The first and most obvious of these problems that the equipment designer has to meet when considering the layout of a fitting for this new type of lamp, is that arising from the long narrow light source. In the case of the modern filament lamp the light source is so small that for many purposes it may be considered a point source, and only in such cases of precise calculations as are necessary in the design of prismatic refractors is it essential to take cognisance

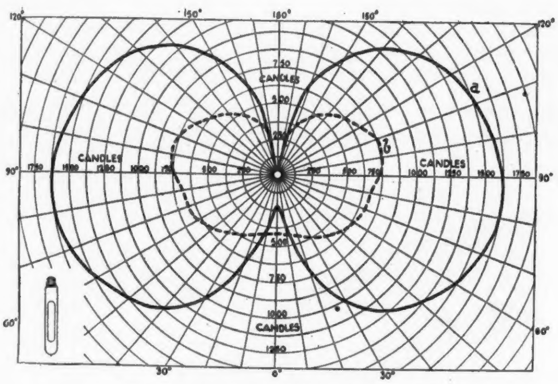


Figure 5. Polar Curve showing Light Distribution in Vertical Plane from (a) 400-watt High Pressure Mercury Vapour Lamp (16,000 lumens) and (b) 500-watt Tungsten Filament Lamp (7,700 lumens)

of the actual size of the filament, but in the case of electric discharge lamps, the length of the columnar light source can never be neglected where any degree of precise light control is attempted.

The second problem which presents itself to the designer really arises from the former and lies in the very different type of light distribution of these lamps compared with ring filament lamps. This difference is shown up by their polar curves (Fig. 5) —taken by kind permission from Mr. Wilson's "Margate" paper—and it is so great as to require the special attention of designers of fittings whether such fittings are required to give a general or a precise control of the emitted light.

A third point that sometimes arises concerns the use of reflectors. It must be remembered that the actual arc which generates the light in these lamps is practically impervious to its own radiations and, therefore, when a reflector is required it should be such as to redirect the light incident on it, outside the zone of the arc, and, because of the double glass tube construction, preferably outside the outer tube of the lamp.

Against these three problems, there is one respect in which the discharge lamp is easier to deal with than ring filament lamps. The relatively large gap in the filament circle of these latter lamps is so large as to cause very different results to be obtained from one and the same fitting as the filament gap is turned first one way and then another. The solid column structure of the light source of discharge lamps avoids altogether this difficulty. There is, however, one further point that might be introduced here, and on which I would like to appeal to lamp manufacturers to help us: this concerns the accurate alignment of the lamp cap with the axis of the lamp. It is no unusual thing to find in filament lamps, the G.E.S. cap set at such an angle to the axis of the lamp bulb that the filament is considerably displaced from the axis of the fitting used with the lamp. In the case of a long tubular lamp such as the 400-watt mercury discharge lamp, any such pronounced inaccuracy in the alignment of the lamp cap would produce a serious tilt and displacement of the light column from its correct position, and would in many cases, prevent a fitting giving its best performance.

TYPES OF FITTINGS.

In order to deal with the many fittings for electric discharge lamps that are now available here, but were not available a year ago, it is essential to deal with them in classes, and it is, therefore, proposed to group them as follows: Reflector fittings; bowl type refractors, built up lanterns.

REFLECTOR TYPE FITTINGS.

It will be remembered that at Margate last year, there was shown an attempt to utilise a large proportion of the light output of a mercury discharge lamp and to give a sharper cut-off by employing what might be called a twin reflector. This reflector gave a symmetrical light distribution, and was more suited to open space and yard lighting than to street lighting. There is now available a modification of a well-known filament lamp fitting in the form of a directional fitting of the twin reflector type, in which one reflector deals primarily with the

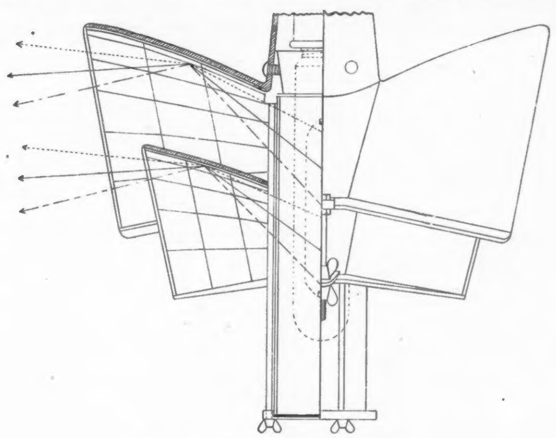


Figure 6. Double Reflector Fitting.

light emitted from the upper half of the light column, and the second or inner reflector deals with the light from the lower half of the column. Fig. 6 shows a side view of this reflector, half in section. The way

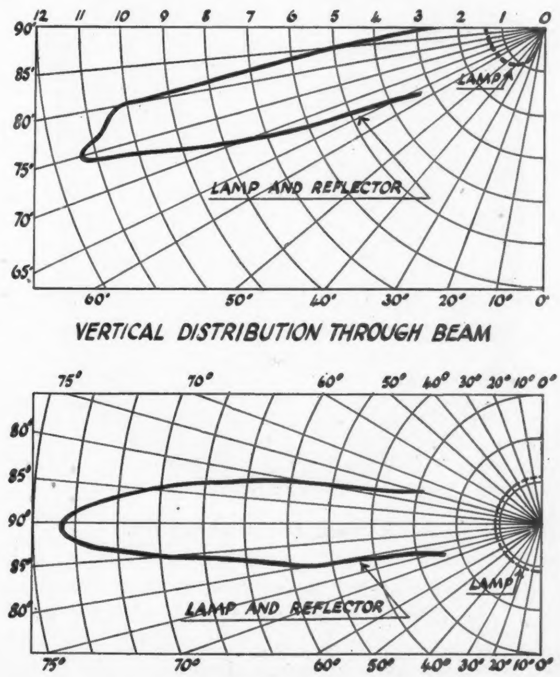


Figure 7. Polar Curves for Fitting shown in Figure 6.

in which isolated points on the reflectors redirect light from different parts of the luminous source is shown by broken lines.

Fig. 7 gives light distribution curves in the form of polar diagrams for this unit.

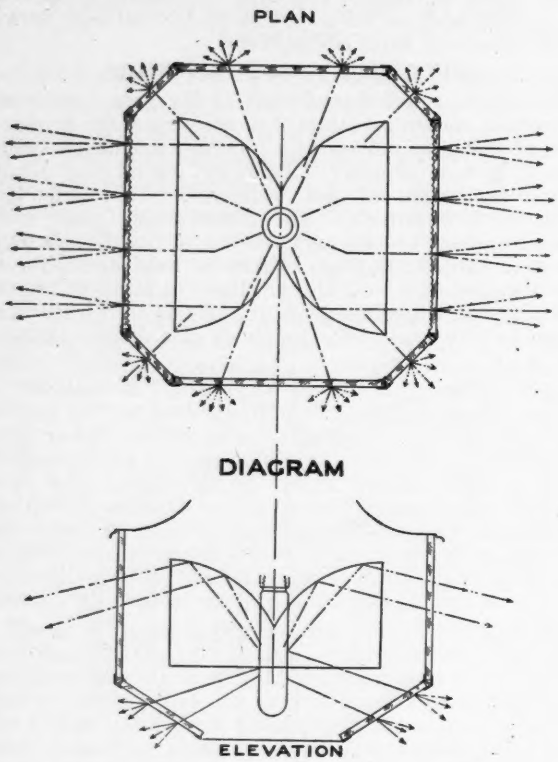


Figure 8. Reflector Lantern with Diffusing Plates.

In order to provide a wider spread in the horizontal direction without further increasing the natural

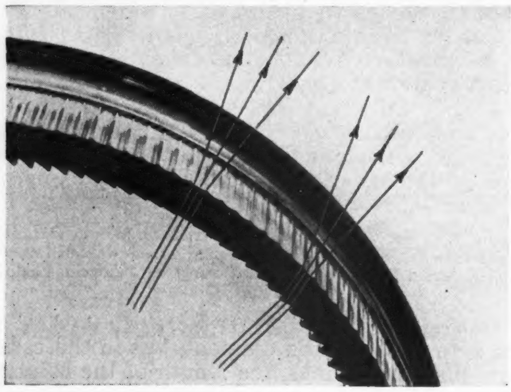
Figure 9. Single Piece Bowl Refractor.

vertical spread of the beam from a directional reflector, one particular arrangement encloses a hood-type reflector within a lantern in which the main faces are fitted with prismatic sheet glass, the prisms running vertically so as to produce a horizontal divergence in the emitted rays. This arrangement for central mounting is shown diagrammatically in Fig 8.

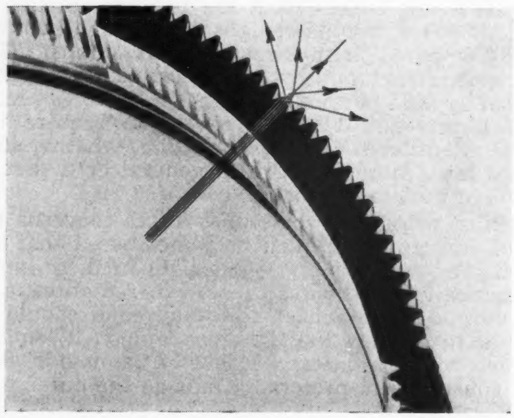
Another lantern designed on the same principle, but very different in appearance, has a pair of adjustable reflectors mounted in the upper part of the lantern, to deal with the light emitted in upward directions by the luminous column, and also four plates of opal glass arranged to reflect a considerable proportion of the light from the lower half of the luminous source into the same general directions as that from the upper half, but in less concentrated beams. In this way, very strong beams are directed on to the side panels of the lantern, which are made of rippled glass to produce the desired diffusion and spread of light in the main beams.

BOWL-TYPE LANTERNS.

In the early days of the electric discharge lamp there appeared to be a general desire to produce a new type of street lighting lantern—perhaps the idea was that the lantern should be in keeping with the new lamp, but, more probably, it was merely the result of a desire to strike a new and more modern note in lantern design. In spite of this desire, there have appeared recently two circular refractor bowls specially designed for use with discharge lamps. Such simple fittings enjoy two marked advantages over the more modern type of lanterns; (a) they are much cheaper; and (b) they can be used as conversion fittings in existing installations.



A



B

Figure 10. Section of Single Piece Bowl Refractor showing Action of Diffusing Flutes.

Considering the simpler of the two bowls first: This is a one-piece prismatic glass bowl, of the straight-sided type, with an inverted truncated conical base (Fig. 9). It is arranged to give two main beams separated by 160°, and the prisms employed in producing these beams are disposed vertically down

the inside of the refractor. In order to give a little horizontal spread to the main beams, the outer surface behind the main redirecting prisms is covered with a series of concave diffusing flutes, the action of which is illustrated in Fig. 10 (a), which shows two narrow pencils of light passing through a cut section of the side of the bowl, and the diffusion produced in these narrow pencils by the external flutes.

On the house and street sides of the refractor deeper external diffusing prisms are arranged to light the regions in between the two main beams (Fig. 10 (b)). By this arrangement of diffusing prisms, the full circumference of the unit appears luminous when viewed from a position along the road.

The base of the refractor is studded externally with light-diffusing cones of differing angles, designed to redistribute the light beneath the unit so as to produce a smooth polar distribution in vertical planes.

The second of these bowl fittings is a two-piece refractor combined with a specular upper reflector (Fig. 11). The outer globe, which is smooth over the whole of its exterior surface, carries groups of vertical prisms and shallow flutes on its inner surface.

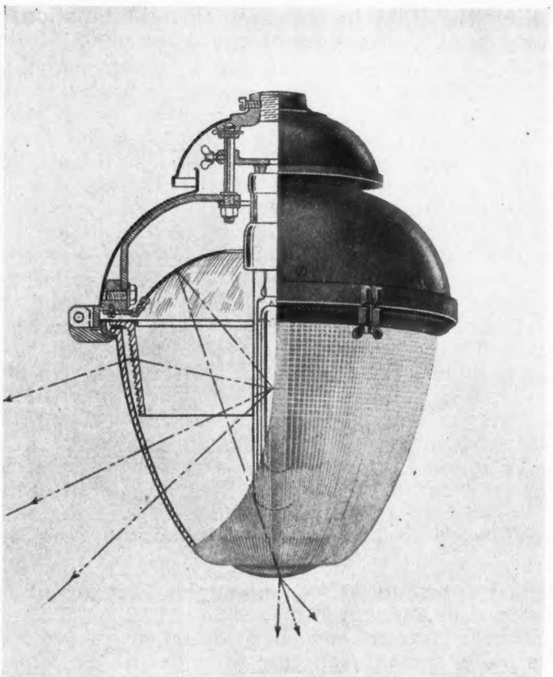


Figure 11. Two Piece Bowl Refractor.

The prisms are arranged to concentrate the light into two main beams at 160° to each other, but on those parts of the globe facing the direction of the road these redirecting prisms do not run down to the base of the refractor. In these lower parts they are replaced, step by step, by shallow diffusing flutes, the reason being that the light projected at relatively high angles needs concentrating into a narrow beam in order to prevent it spreading over too wide an area at the distance at which it comes down to the road level, but light projected more steeply toward the road needs to have a wider spread in order to cover the width of the roadway at the nearer distances. The whole of the interior surface of this globe is very lightly satin finished, thus improving the unlighted and lighted appearance of the fitting, and also removing the harshness of the main beams.

The second portion of this unit is an inner refracting band round the upper portion of the bowl. This band carries horizontal prisms on the face, which lies adjacent to the outer member. These prisms are designed to effect some control over the light which is ordinarily wasted by being projected up into the air. The prisms return some of this light into useful directions, and in so doing cause the upper part of the outer globe to be luminous from all angles at which the appearance of a street-lighting fitting is of importance. The third essential part of the fitting is a specular reflector which collects and returns the light that is ordinarily lost out of the upper part of bowl fittings. This reflector is designed to return the light incident on it down to the lower part of the bowl, thus filling in what would otherwise be a dark area caused by the fact that the luminous column does not extend to the bottom of the lamp. In this way it helps the lighted appearance of the fitting, and also removes the dark spot underneath the lamp which would otherwise be present owing to the peculiar nature of the light distribution from the bare lamp. The combination of these three parts ensures that from all ordinary angles of view the whole of the bowl is luminous. A light distribution curve in the vertical plane through a main beam is given in Fig. 12.

Apart altogether from its use as a fitting for adaptation purposes, an interesting lantern has been de-

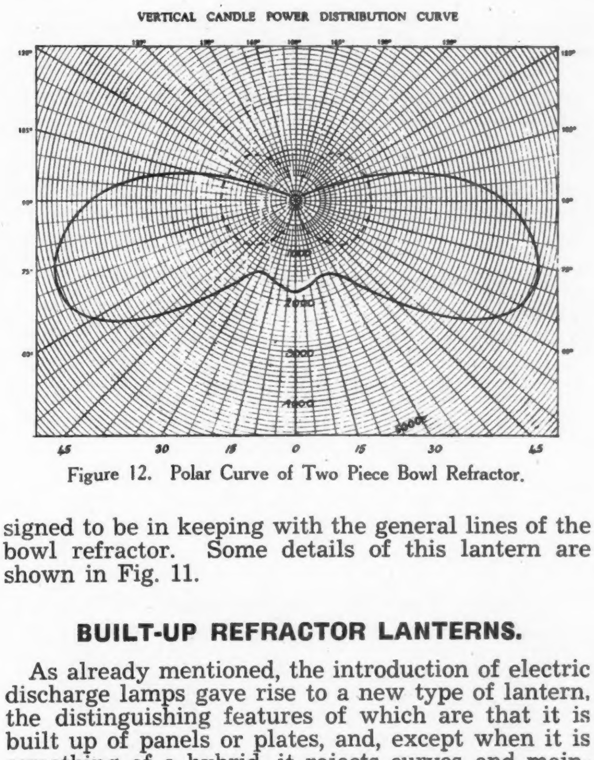


Figure 12. Polar Curve of Two Piece Bowl Refractor.

signed to be in keeping with the general lines of the bowl refractor. Some details of this lantern are shown in Fig. 11.

BUILT-UP REFRACTOR LANTERNS.

As already mentioned, the introduction of electric discharge lamps gave rise to a new type of lantern, the distinguishing features of which are that it is built up of panels or plates, and, except when it is something of a hybrid, it rejects curves and maintains the modern straight-line contours throughout. Some lanterns of this type were shown at Margate, but during the intervening twelve months their number has been augmented, and a few interesting features have been introduced. For example, in order to obtain beams at, say, 160° to each other, the practice which was adopted in the earlier lanterns of using a 180° lantern and offsetting the lamp has not been followed in some of the more recent designs. Instead, a special lantern is used for side-street mounting, having the prismatic plates arranged at 20° to each other, and the lamp is located along the normal from the centres of the plates. In theory, at any rate, such an arrangement should give better results. This reasoning has been followed one stage further in some lanterns, and the prismatic plates have been tilted from the vertical so as to lie approximately normal to the main projected beams both in the vertical and the horizontal plane. Another interesting feature in which some of the newer lanterns differ from the earlier ones, concerns the way in which differing beam strengths

and spreads are obtained on opposite sides of the lantern should this feature be required. In these lanterns the lamp is ordinarily arranged a short distance behind the optical focus of the prismatic plates, providing two similar beams of fairly strong intensity and with a fair spread horizontally. If a strong concentrated beam is required on one side, the lamp is moved up towards that plate—i.e., nearer to the optical focus—thus the plate actually collects more light, and concentrates this light into a narrower and consequently more intense beam. At the same time the beam from the other plate is weakened and spread over a wider angle. Theoretically there is a risk of the latter beam becoming weak in the middle (or

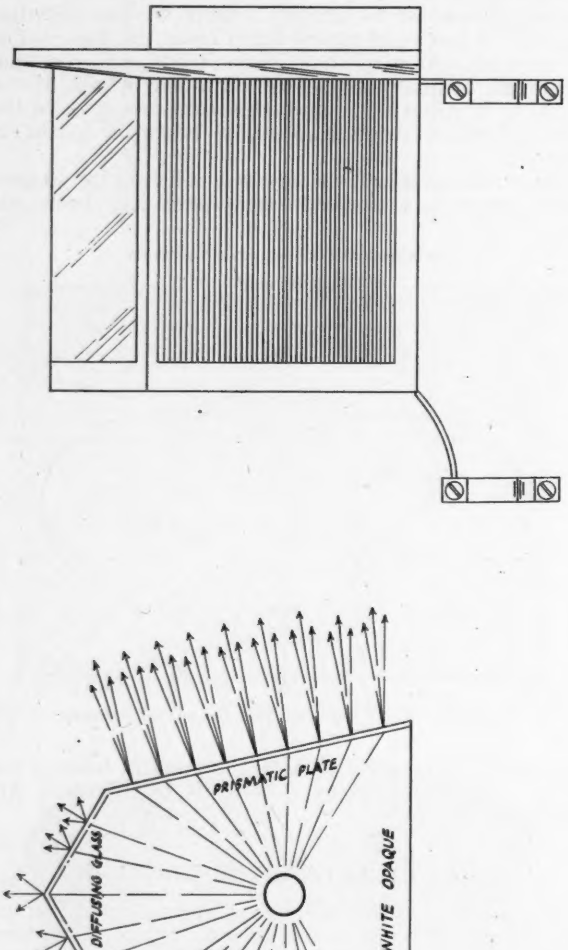


Figure 13. Built up Lantern with Vertical Sides.

hollow), but since these lens plates are always velvet finished, and since the additional spread given to the beam is relatively not very large, the scheme seems to work quite well in practice.

The simplest lantern of this type is cubical in shape, and carries parallel prism lens plates in two opposite sides, the other two sides and the base are fitted with diffusing glass panels. In order to redirect some of the concentrated beam that is projected upwards, horizontal specular reflectors are provided on the underside of the canopy adjacent to the prismatic plates. A modification of this lantern specially designed for side-street mounting carries the same prismatic lens plates arranged at an angle to one another, so as to be at right angles to main beams separated by 155°. The front of the lantern contains two panels of diffusing glass meeting at an angle, the better to light the areas in between the main beams. As in the simpler lantern, some of the upward directed light is returned to the road by mirrors arranged in the canopy. Diagrammatic views of this lantern are given in Fig. 13, showing the way in which the light is controlled and redirected by the glass panels

In order to try to minimise the considerable loss of light in an upward direction that has been several times mentioned, and at the same time retain one side of the prismatic plate completely smooth, a new type of prismatic lens plate has been produced. The lower half of the plate carries parallel prisms of a length equal to the length of the light column in the 400-watt lamp. They are designed to concentrate the light emitted by the lamp in a downward direction into the direction of the road, no other control being necessary. The upper half of the plate carries semi-circular lenticular prisms, adapted to redirect both vertically and horizontally a considerable proportion of the light emitted by the lamp in upward directions into useful street-lighting directions. Besides controlling the light in the way, this combination of prisms has the advantage of giving the plate a fully-

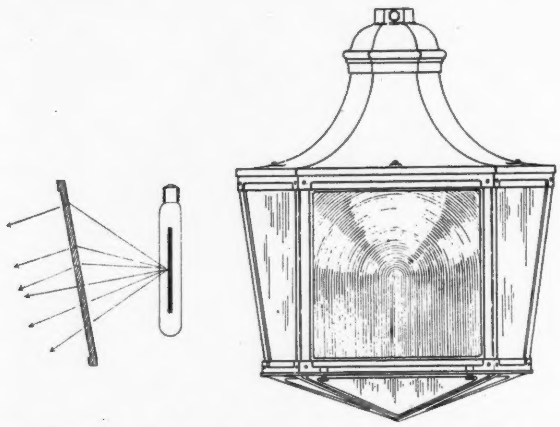


Figure 14. Built up Lantern with New Prismatic Plate.

flashed appearance from all angles that are of importance in street lighting.

Several lanterns have been designed for use with this plate, and in each case the sides of the lantern are arranged at an angle of about 10°-15° to the vertical, so as to bring the face of the lens plate approximately at right-angles to the direction of the main beam, as shown in Fig. 14. In another lantern, Fig. 15, specially designed for side of street mounting the plates are tilted from the vertical, and also set at an angle to each other, so that they lie in what may be termed a double V formation. The idea behind this scheme is obviously that the plates should lie normal to the direction of the main beams. The remaining panels of these lanterns are obviously of diffusing glass. It is too early to give light distribution diagrams from these lanterns.

HORIZONTAL MERCURY DISCHARGE LAMP.

In the preceeding sections two technical difficulties have been frequently mentioned: (a) the difficulty of controlling satisfactorily the upwardly emitted light from a vertical electric discharge lamp, and (b) the need for arranging some means of diffusing the beam produced by directive fittings so as to get sufficient beam spread to cover even moderately wide roadways. These difficulties are both due to the dimensions of the light source and to the fact that the length of the source is disposed vertically. An interesting

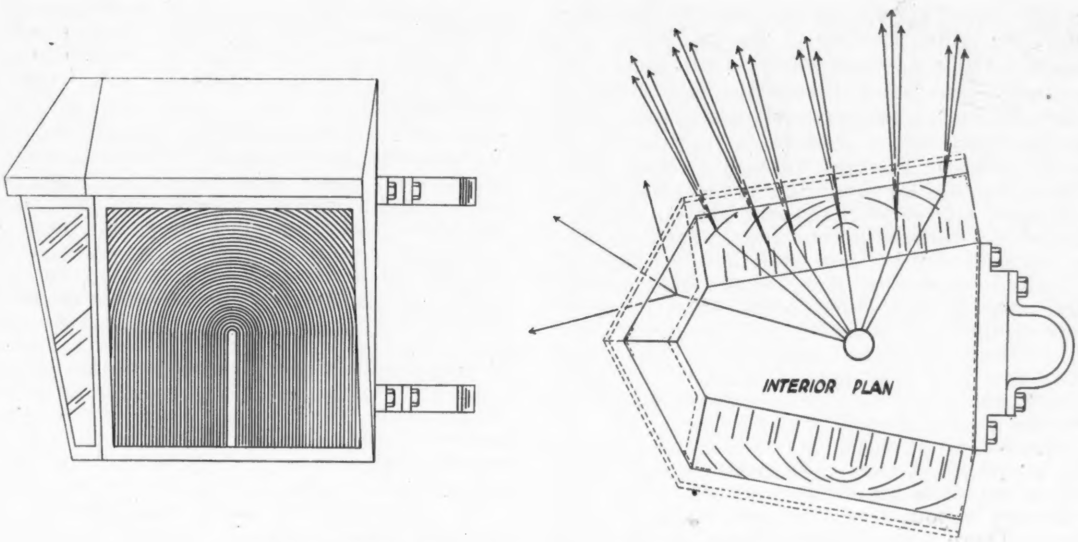


Figure 15. Built up Lantern with Plates normal to Main Beams.

fact arises from the examination of polar curves of fittings using vertical mercury lamps—both fittings designed specially for use with these lamps and also standard directional fittings. In practically every case, if the vertical and plan curves in a 75° cone were interchanged they would be excellent curves for street lighting purposes. This and other considerations suggest that if the lamp were burned horizontally much more effective fittings could be designed for use in connection with it. As a matter of fact with a horizontal tubular burner, the wide spread beam necessary to cover wide roads comes automatically and by the use of either reflectors or refractors it is easy to produce almost any light distribution that may be desired, and at the same time the beam can be so accurately controlled as to eliminate glare for all practical purposes.

Since the writing of this paper was begun, news of a horizontal burning mercury vapour discharge lamp has come to hand (horizontal sodium vapour lamps have been available on the Continent for some time—see later). The troublesome arching of the luminous column when ordinary mercury vapour

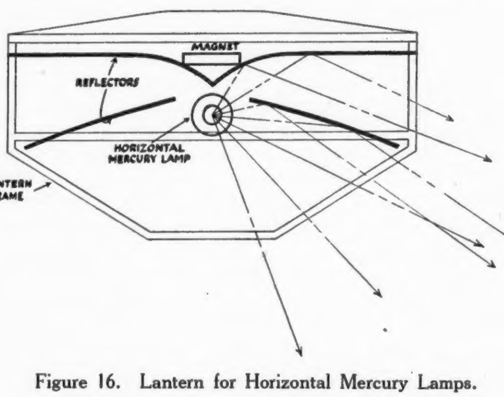


Figure 16. Lantern for Horizontal Mercury Lamps.

lamps are burned horizontally has been overcome by a magnetic control over the arc, by means of which it is made to retain its straight line shape. A lantern designed originally for use with vertical burning lamps has been fitted with suitable reflectors and adapted for use with this newest type of lamp. Two pairs of reflectors which are curved in one plane only, are arranged with their edges lying alongside the lamp as shown diagrammatically in Fig. 16. A polar curve obtained by this arrangement is shown as " B " in Fig 17, and for comparison purposes a polar curve " A " obtained from the same lantern using a vertical burning lamp is plotted to the same scale. The increased efficiency of the horizontal arrangement is obvious, and the fact that there is practically a sharp cut-off at 80° confirms the suggestion made earlier that with a horizontal burning lamp troublesome glare can be practically eliminated. On the other hand, the curve for the vertical burning lamp shows a fair beam strength in the region from 80° to 90° and shows a considerable wastage even above the 90° line.

SOME DEVELOPMENTS ABROAD.

FRANCE.—As already indicated, a demonstration of modern street-lighting fittings was organised from

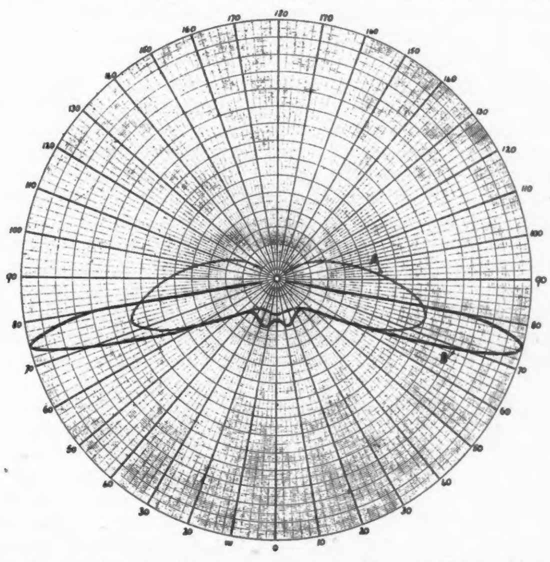


Figure 17. Polar Curve for Lantern shown in Figure 16. A, with Vertical Mercury Lamp; B, with Horizontal Mercury Lamp.

May 28 to 31 of this year by a group of companies interested in their manufacture, on the experimental roadway belonging to the City of Paris. The surface of the road was light-coloured concrete, but unfortunately the colour was not uniform throughout the whole stretch, and consequently some sections favoured the installations serving them more than did other sections. Also the road was roughly in the form of an ellipse, and the bends were well banked. As the lamps were always arranged on the inside of the bends, the surface of the well-banked sections was brought appreciably nearer the normal to the

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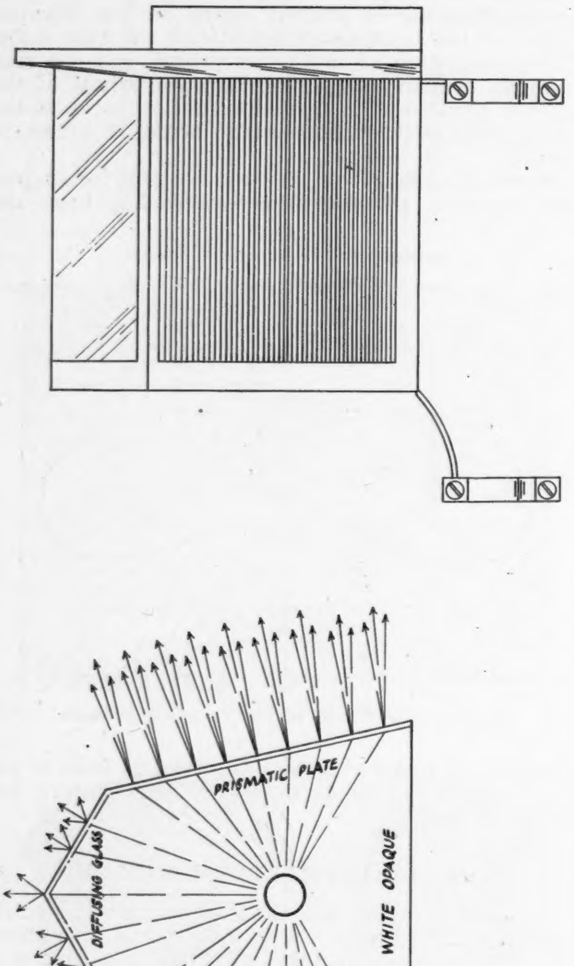

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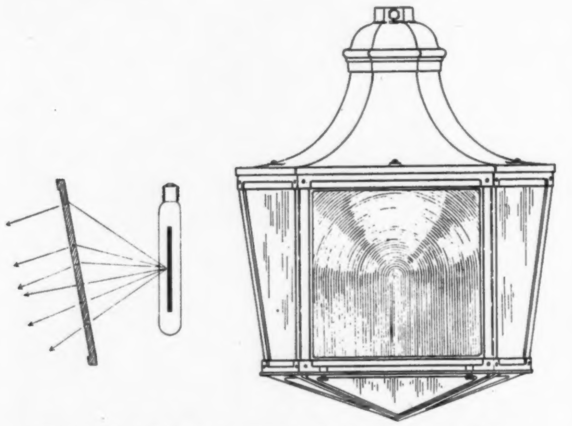

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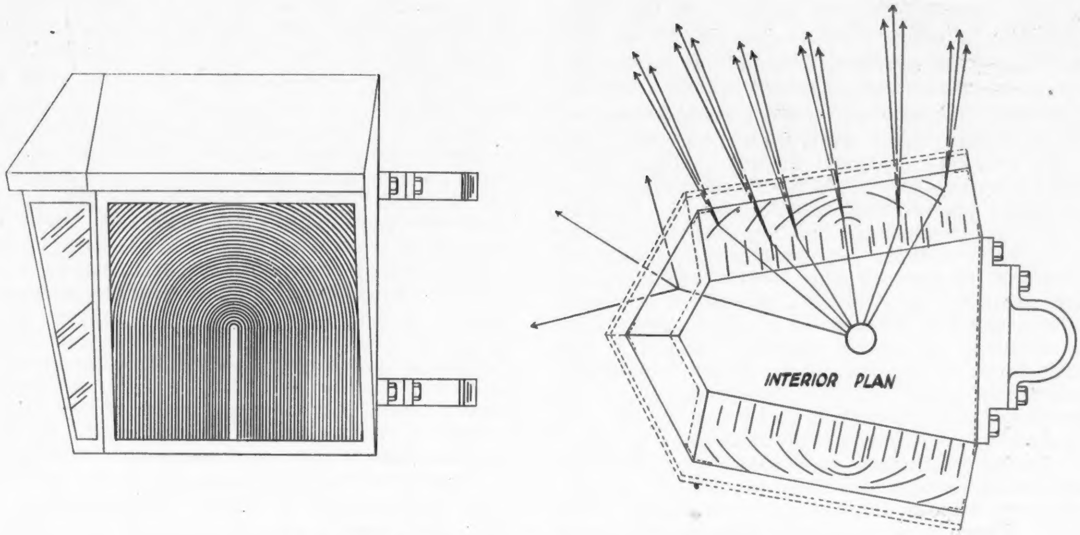

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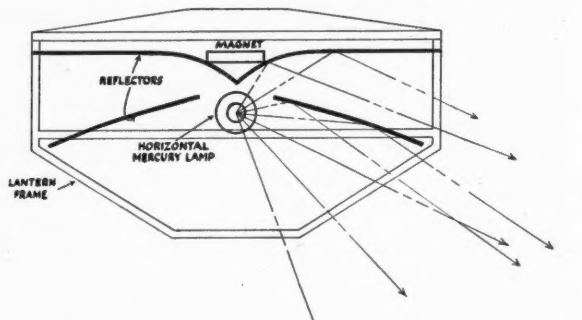

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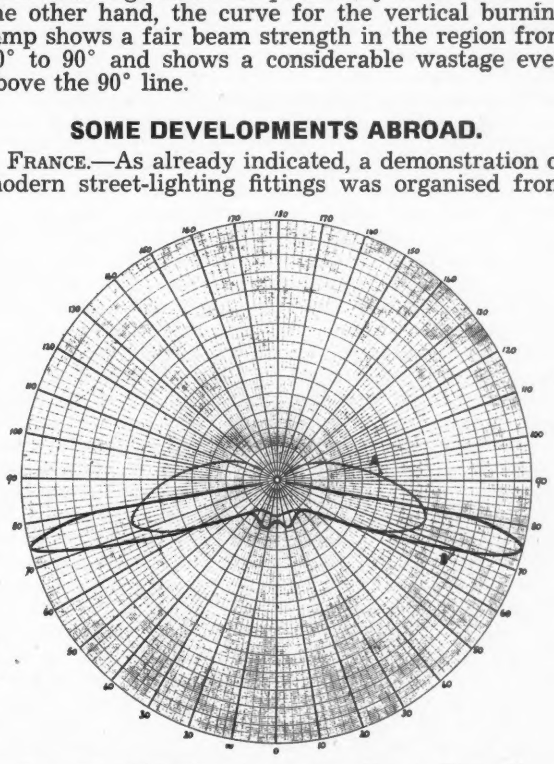

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rays of light passing from the lamp across the roadway, thus the reducing effect of the $\cos^3$ factor was minimised. Despite these minor criticisms, the demonstration was most instructive and helpful. Naturally electric discharge lamps came in for a good deal of attention. There were three types on view. each with specially designed fittings. They were (a) Mercury vapour lamps similar to those used here —two groups; (b) vertical burning sodium vapour lamps, and (c) horizontal burning sodium vapour lamps. In each of these four systems the height of mounting and the spacing were kept constant at 8m. and 35m. respectively, giving a mid-point angle of incidence on the line between two consecutive lamps of 66°. Such a close spacing height ratio obviously favoured reflectors as against refractors, but since three out of the four systems employed reflectors, the choice of such a close spacing can be easily understood. Considering these four systems in the order in which they were given on the official invitation card, there was first an installation of 250-watt mercury vapour lamps in open silvered glass reflectors. There was plenty of light on the road surface, but the lighting was somewhat patchy, due to the peculiar light distribution given by the mercury vapour lamp and to the use of a reflector which it appeared (to me, at any rate) had been designed for use with filament lamps. Probably the best lighted part of the road was in the mid-zone area, where the light from adjacent lamps was concentrated; while the darkest part of the road was immediately underneath the lamps. Then followed another installation of 250-watt mercury lamps in fittings composed of a large ellipsoidal reflector of silvered glass, housed in a metal fitting and closed at the base by a dish-shaped glass satin finished on the inner surface. In this installation the uniformity was remarkably good. Being mounted on the side of the roadway, the spread of light across the road from what we would call an axial or 180° type of fitting, was obtained by tilting the whole fitting until its axis was pointing towards the centre of the road. By this means the centre lines of the two axial beams of light were brought coincident with the centre line of the roadway, and very satisfactory results were obtained. At first, the fitting hanging a little out of the perpendicular was rather disconcerting, but the results fully justified the method of obtaining them, and the unusual angle of the fitting was soon disregarded.

Next came two systems using sodium vapour lamps; the rich warm yellow glow of these lamps was in sharp contrast to the cold light of the mercury vapour lamps. By comparison, the colour of the sodium lamps appeared to be the less objectionable, and there certainly seemed to be something in the claim that the light from these lamps assists visibility to an unusual degree. The first of these installations employed 120-watt horizontal burning lamps, fitted in inverted trough-like lanterns with pairs of refracting plates lying along the sides of the lamps. A steeply sloping roof-like reflector, giving a sharp cut-off at about 80° from the vertical, completed the lantern. The distribution of light from these fittings was all that could be desired, both as regards uniformity and spread over the road. Though the actual intensity of illumination on the road surface was distinctly less than that given by the larger mercury lamps, the appearance and the visibility on this stretch of roadway was quite satisfactory.

The last section was an installation of 250-watt vertical burning sodium vapour lamps housed in vitreous enamelled reflectors. These reflectors were much larger and wider than any used for road lighting in this country, and were obviously designed to give a good throw of light across the roadway and to a certain extent in the direction of the road. They certainly achieved this and gave plenty of light around the foot of the post and immediately across the road, but even at the close spacing-height ratio employed, there were distinctly dark zones in between lamps, so that this system would not show up very satisfactorily if judged by our "test point" illumination.

Germany.—The position as regards the adoption of discharge lamps in Germany appears to an outsider to have been rather confused, but at the present time it appears to be clarifying. One result of that indecision is that, though they have quite a number of really first-class installations of electric discharge lamps for road and street lighting, they have not the wide range of well-designed fittings of different types that we have got. At the moment the prevalent idea is that horizontal burning sodium vapour lamps should be used for the lighting of motor roads, while in Urban areas mercury vapour lamps may be used, provided the fitting also accommodates a number of ordinary filament lamps to give some degree of "correction" to the colour of the emitted light.

In connection with motor road lighting a fitting that has been used successfully consists of an enamelled iron reflector in the form of an inverted trough, the axis of the sodium tubular lamp lying along the length of the trough. These are generally mounted at a height of 10 metres (33 feet) and spaced 25 metres (83 feet) apart, but in the case of the Berlin-Hamburg Road the spacing is only 20 metres apart, giving a spacing-height ratio of only 2 to 1. At such close spacing-height ratios they naturally provide excellent illumination on the road surface. In spite of quite a number of excellent installations of this and similar types, a curious reversal of procedure appears to receive favour at the moment. In the opinion of the Chief Inspector of the road lighting committee, the technique of motor road lighting has now proceeded so far that the units should in future be mounted on concrete pedestals about 1.2 metres (4 feet) in height. It is proposed that these pedestals should be arranged at intervals of 50 metres on the right-hand side of the unidirectional tracks of motor roads. The lighting equipment should accommodate horizontal burning sodium vapour lamps and should project a highly concentrated beam only in the direction in which the traffic is moving. The emitted light should be screened off sufficiently to prevent too much spread across the road and must be strictly confined below the horizontal, so that drivers coming in the opposite direction will not be inconvenienced by glare.

Even if these requirements are satisfactorily met, which will not be easy to accomplish, it would appear that the driver of a car would always be peering into his own shadow. It may be, however, that any disturbing shadow would only extend in front of the car for a limited distance, and that the stretch of roadway well in front of the car, which it is necessary to see distinctly when driving at a fair speed may be quite clear. In any case, the suggestion is interesting, and the experiment will without doubt yield most useful information. It will, therefore, be welcomed by all who are interested in motor road lighting.

ACKNOWLEDGMENTS.

It must be obvious to everyone that in the preparation of this paper I must have had the willing help and co-operation of a large number of people. As a matter of fact I have been particularly fortunate in this respect, for I have received far more information—freely and willingly given—than I have been able to embody in the paper. To all who have thus helped me I wish to tender my thanks, and to those, whose information has not found a place in the paper (for reasons stated in the introduction) I also tender my apologies.

Without in any way attempting to differentiate, I would like to acknowledge my indebtedness to the

following firms and members of their staffs: Messrs. The British Thomson-Houston Co., Ltd., Messrs. W. Edgar and Sons, Ltd., Messrs. The Edison Swan Electric Co. Ltd., Messrs. The Electric Street Lighting Apparatus Co., Messrs. The Engineering and Lighting Equipment Co., Ltd., Messrs. The Gas Light and Coke Co., Messrs. General Electric Co., Ltd., Messrs. Holophane, Ltd., Messrs. W. Parkinson and Co., Messrs. Philips Lamps, Ltd., Messrs. Revo Electric Co., Ltd., Messrs. William Sugg and Co., Ltd., Messrs. The Wardle Engineering Co., Ltd. Concerning developments in Germany I would like to thank Messrs. A. E. G. for providing information regarding their own equipment and Mr. L. J. Franck for collecting and transmitting data concerning other developments.

DISCUSSION.

The PRESIDENT, in expressing appreciation of the author's very comprehensive review of the present position, called special attention to the very fine installation of gas lighting in Chapel-street, Aberdeen, where the Gas Light and Coke Co. had supplied six eight-light No. 2 mantle low pressure gas lamps of entirely new design employing glassware specially developed by the author's firm to bring about the desired light distribution. This installation, he said, gave an excellent spread of light.

Mr. G. H. WILSON (Wembley) said the impression made upon his mind by some of the fittings mentioned in the paper was that there was a tendency towards complication, whereas the design of fittings should be as simple as possible. As an example of what could be done he showed a lantern slide of a fitting consisting of a simple opal globe containing one of the new electric discharge lamps. At first sight, said Mr. Wilson, it might appear that this had been designed by a draughtsman with a piece of charcoal on paper, but actually it was a careful laboratory design. He also exhibited a lantern slide showing the type of distribution obtained with this globe, the light being re-directed in the downwards direction and producing quite a wide spread of light with maximum intensity at about 60 degrees to the vertical, the sort of illumination required for intersections and open spaces where a pleasing diffusion was required.

Referring to the correct fitting of lamps in lighting equipment, Mr. Wilson said that, having given some study to this matter, he was convinced that it was not the lamps or the holders which were chiefly to blame, but the assembly of the lampholder in the fitting. The lampholder was frequently screwed on to a piece of gas barrel or was gripped in the fitting in some way, with the result that there was a skew assembly, which caused considerable trouble from the point of view of correct light distribution.

Commenting on the horizontal burning mercury vapour lamp, Mr. Wilson said this was an important development and worthy of the closest attention. The fact that the efficiency of such a lamp was increased was obvious, but if by efficiency the author meant effectiveness as a light source, then he did not think all the facts had been taken into consideration. At Wembley they had made an investigation of the probable performance of a linear source of this kind burning horizontally and vertically. A standard fitting was used for the vertically burning lamp and an experimental fitting was used for the horizontally burning lamp. A slide was then shown of the iso-candle diagram of the vertically burning lamp. It was emphasised from this diagram that there was quite a lot of light coming above the horizontal, and that there were quite good intensities very near the horizontal.

A second slide was then shown of the same lamp burning horizontally in a fitting specially designed for it, and it was pointed out how the intensities had gone up in the peak region, which was very much higher than in the previous slide. There was greater efficiency, but the higher intensities had been obtained by taking the light away from directions above and just under the horizontal, so that the intensity there was reduced. Therefore, whilst the horizontally burning lamp in that case gave a higher efficiency, he did not think it gave such an effective form of lighting. There would not be such a high uniform road brightness, the type of shadowless lighting which people talked so much about and which could be obtained with the vertically burning lamp. In order to obtain that shadowless lighting with the horizontally burning lamp, it would be necessary to reduce the intensity in the maximum region and to increase the amount of light near the horizontal. By the time that had been done, the total amount of light falling on the road would have been reduced to something probably in the neighbourhood of that obtained with the vertically burning lamp. Therefore, whilst the horizontally burning lamp was a most important development to follow up, we must not be carried away unduly by talk that this type of lamp would solve all our problems.

Mr. J. KEMP (London), referring to the experiment on the road in France with yellow lamps—mentioned by the author—said he had seen that installation, but whilst agreeing that visual acuity is infinitely better with yellow motor-car lights, it was a different matter when it came to street lighting, and it was a moot point whether yellow lighting in general would facilitate the perception of objects on the roads. There was also the fact that various types of road surface finish gave different results whatever the type of lighting. Referring to the horizontally burning electric discharge lamp, he believed the main object in developing it was to get an effective cut-off in the region of 80 degrees from the vertical in order to reduce glare and add to the general visibility on the road, and for that reason he was more than interested in that type of lamp.

Mr. D. G. SANDEMAN (Edinburgh), referring to the satin-finished glassware mentioned in the paper, asked why this should be used with prisms. Surely with prisms something could be obtained which would do the whole job.

Mr. F. A. C. PYKETT (Coventry) asked if consideration had been given to the use of prismatic glass with high-pressure gas lighting.

Mr. G. BRAIDWOOD (Coatbridge) enquired of the author why volumetric comparisons had been given in the paper in the case of gas, having regard to the fact that the gas industry abandoned the volumetric basis fourteen years ago when it adopted the therm. He was referring, he said, to the consumptions of gas in the lamp which the Gas Light and Coke Company had been experimenting with.

Mr. H. S. ALLPRESS (Birmingham) suggested that the difficulties with regard to accurate focussing of lamps in fittings are not due entirely to the lampmaker or the fittings-maker alone, and urged the necessity for the two to co-operate in this matter. Referring to the breakage of glass, he said this is a problem of temperature gradient rather than temperature, and added that he had found that by using two thicknesses of glass, a more uniform temperature was obtained which prevented the breakage of the prismatic sheet-glass. As regards a definite cutoff to prevent glare, that was used in a well-known type of reflector on the Continent, but for some reason it did not seem to have been adopted here. This type of reflector gave remarkable visual acuity, and should be applicable to arterial road lighting, but for some reason it did not seem to be acceptable to English mentality. The horizontal gaseous discharge lamp, continued Mr. Allpress, appeared to offer a solution on the basis of actual illumination on the surface, but in his view sufficient attention was not being paid to the importance of road brightness. He suggested that the type of fitting likely to be used

in the future would be a horizontal lamp in a lantern similar in shape to the present vertical type, but with an entirely new optical fitting.

Mr. E. STROUD (Holophane, Ltd.) agreed that lantern design should be kept as simple as possible consistent with effectiveness. He anticipated that in the near future there will be a range of electric discharge lamps which will enable the whole system of lighting to be carried out without using the higher candle-power lamps which at present are the only ones obtainable.

Mr. C. C. PATERSON (General Electric Co., Ltd.) referred to the comments which had been made during the discussion as to what might be regarded as the ideal distribution for street lighting and urged that this matter should be approached very carefully. He suggested that after the papers that were to be presented at the afternoon session had been considered, it would be possible to fix ideas more clearly and to look into the future and see possible ways of lighting which might involve greater intensities in the horizontal direction and which at the same time might not be so serious as some people thought from the point of view of glare.

Mr. F. C. SMITH (Gas Light and Coke Co.) remarked that Mr. Paterson had to some extent been thinking along similar lines as himself. Some speakers had advocated a high intensity beam near the horizontal, whilst others had deprecated the use of such a beam; but, after all, what was glare? In spite of the difficulties which might be presented by the size or geography of the source of light, the paper had shown quite clearly that the makers of refracting glassware and reflectors could give lighting engineers practically any distribution they required. It was, therefore, a great thing to know that when lighting engineers had made up their minds what they really wanted, there was a scientific reserve in this country which could supply their needs.

Dr. ENGLISH, in the course of his reply, first thanked the President for his complimentary remarks concerning the Paper, and then said he was pleased Mr. Wilson had shown a photograph of the opal bowl fitting for electric discharge lamps. This was an example of the rapid progress that was being made at the present time, and indicated the way in which a paper of this kind, though only written up a month ago, was out of date by the time it was presented. On the question of the alignment of lamps in fittings, he admitted that the method of securing lampholders sometimes was a source of trouble; but he was not prepared to admit that this was the major cause. It was common knowledge that G.E.S. caps were very frequently badly aligned on the lamp necks.

Regarding Mr. Wilson's comments on the horizontal burning electric discharge-lamps, he was afraid that his results did not agree with Mr. Wilson's suggestions. He would like to assure him that it was possible to design a fitting for such lamps which, when compared with vertical lamp fittings, was more efficient and at least equally effective.

Replying to Mr. Sandeman, Dr. English said that prisms could be designed to give the desired degree of diffusion, but satin finishing was used in one unit referred to in the Paper, because it gave a softening effect to what some people looked upon as a hard glaring light.

As to the use of prismatic glass with high-pressure gas, it was difficult enough to get a glass which could be moulded satisfactorily and would stand up to low-pressure gas. (Since the meeting, however, some very interesting and satisfactory tests with prismatic glass dishes and high-pressure gas have been made: the results may soon be made public).

Answering Mr. Braidwood's question concerning the volumetric comparisons for gas consumption given in the Paper, Dr. English said that data had been supplied to him in that form, and it seemed to have advantages over expressing them as small fractions of a therm, as differences then would appear negligible.

Finally, Dr. English agreed with Mr. Smith in his suggestion, that when street lighting engineers had made up their minds as to what they wanted, their needs could be met; but so long as one street lighting engineer wanted one thing and another wanted something quite different, and the Lighting Committee had different ideas, designers of fittings would be in an awkward position; but they had one consolation—there was always a chance that somebody would choose whatever fittings they designed.

Novel Lanterns in Liverpool

Through the courtesy of Mr. R. E. Rogers, we illustrate below one of the novel octagonal lanterns recently installed by him in Liverpool. The poles, of reinforced concrete, are 42 ft. overall, giving a mounting height of 35 ft. to the source of light. The lanterns are capable of housing either eight or sixteen gasfilled lamps of 1,000 watts each. Alternate lamps can be extinguished at midnight or any other predetermined time. Those illustrated contain eight lamps, four of which are turned out at midnight.

Each lamp is furnished with an adjustable vitreous enamelled iron reflector, enabling the light to be directed as desired. The lower portion of the lantern is of flashed opal glass.

Mr. Rogers also sends us photographs of other concrete columns of octagonal section, which are being used for residential street lighting. The mounting height in this case is 14½ ft. Special attention has been devoted to the design of the lanterns, also octagonal and of opalescent glass.

Lieutenant-Colonel C. J. Falk

We learn with interest that Major C. J. Falk, M.C., one of the directors of Falk, Stadelmann and Co., Ltd., has been promoted to the rank of lieutenant-colonel and selected for command of the 5th Battalion (Territorial) the Manchester Regiment, in succession to Lieutenant-Colonel and Brevet-Colonel G. E. Allen, T.D., whose tenure expired on September 20, 1934.

Major Falk is the senior major of his battalion, and succeeds to the command after four years in the rank. He was in France with his battalion, including employment in 1917 as instructor, 26th Divisional Infantry Base Depot, and duty with a service unit. He obtained the Military Cross. Returning to his Wigan battalion as captain, he got his majority in 1930 on the promotion of Lieutenant-Colonel G. E. Allen, T.D., to command.

A New Lighting-Up Time Table Based on Illumination Requirements

By

G. H. WILSON, B.Sc. (Eng.), A.M.I.E.E.

(Communication from the Staff of the Research Laboratories of the General Electric Company, Ltd., Wembley, England)

Paper presented at the Eleventh Annual Meeting and Conference of the Association of Public Lighting Engineers, held in Aberdeen during September 17th to 20th, 1934.

ABSTRACT.

A lighting-up and extinguishing time-table for public lighting is given for latitudes 50° N. to 59° N. The table is calculated on a basis that lamps should be lighted or extinguished at a time when daylight illumination on an overcast day has fallen to a value at which vision outdoors becomes uncertain. Details of the calculations are given. Check observations extending over a year have confirmed the times calculated, and have not suggested that any modifications are required. Some data on daylight illumination values at dusk are given.

It is a common sight to see public lighting lamps burning while it is still broad daylight. And it is not unknown for lamps to be unlighted after darkness has fallen. These occurrences may be the result of errors in the setting of time switches, but often the cause is that the time chosen for lighting or extinguishing the lamps has not been the most suitable which could have been found. There are many tables in use in various parts which recommend times of lighting-up and extinguishing street lamps. For the most part their origin is obscure, and in others, the times are usually found to have been based on the times of sunrise and sunset throughout the year.

The time at which it is desirable for public lighting to be turned on or off must depend on the level of daylight illumination. When daylight falls below a value at which visibility becomes uncertain, the lamps should be lighted, and when it rises above the same value they can be extinguished. If they come on unnecessarily early, or go off unnecessarily late, there is waste of energy, and if they come on late, or go off early they are not serving the purpose for which they were installed.

By means of a light sensitive relay, it is possible to arrange for the lighting to be switched on and off automatically at the appropriate daylight illumination. Devices of this kind are now in use, but their employment is by no means general, and the time-switch is far more commonly found. Each system has its merits, but this paper is not concerned with them. It was in an endeavour to find a basis on which the times of lighting and extinguishing could be decided that the present investigation was made. It is to be hoped that the results will be of value for the arrangement of the lamplighter's schedule, the setting of time-switches, and the design of the automatic time-changing mechanisms which are now fitted to some clocks.

PRINCIPLE OF THE NEW TABLES AND CURVES.

The source of daylight is the sun. With its rising in the east, the daylight illumination increases until noon. After passing the meridian the sun becomes lower in the heavens, the illumination gradually falls, and finally the sun sets in the west.

During the day the sun describes an arc in the heavens, and its apparent path varies with the time of year. In summer it reaches its maximum altitude, and in winter its minimum. Some of the paths for various times in the year as they would appear to an observer looking south-east at London, are shown diagrammatically in Figure 1. In the drawing, the vault of the heavens is represented as a hemisphere and the horizon as the base of the diagram. In latitudes higher than that of London the sun's path would be more nearly horizontal; whilst further from the poles it would be more nearly vertical.

For any point on the earth, defined by its latitude and longitude, it is clear that the daylight illumination, to a first approximation, will depend on the sun's distance above or below the horizon, as seen from that point. For a given position of the sun relative to the

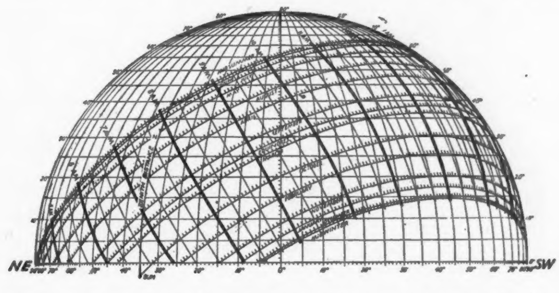


Figure 1. Apparent Paths of the Sun. S.E. aspect, latitude 51° 28′ N. at Greenwich.

horizon, the illumination will always be the same. The amount of cloud, the clarity of the atmosphere, and the obstruction of buildings will cause variations in the illumination, but these factors can be dealt with later. For the moment it will be assumed that the sky is clear and that there are no obstructions.

Sunset is defined as the time for any point on the earth at which the sun's upper limb just disappears below the visible horizon. The times for any year for a number of latitudes are given in the Nautical Almanac.* As the sun sinks further, the illumination will fall until eventually it reaches a value at which it is desirable for the artificial lighting to be used. There is a definite angle of the sun below the horizon at which this illumination will be produced. This angle can be calculated, and it will hold good throughout the year for any place. Having once determined the sun's position corresponding to the daylight illumination at which it is desirable to light and extinguish lamps, then calculations can be made which will give the time in the morning and in the evening each day, at which the sun has this position. The result of such calculations is a lighting-up and extinguishing time-table based upon daylight illumination values, and this is the basis of the present tables and curves.

* Published annually by H.M. Stationery Office. The edition abridged for the use of seamen is probably the most convenient.

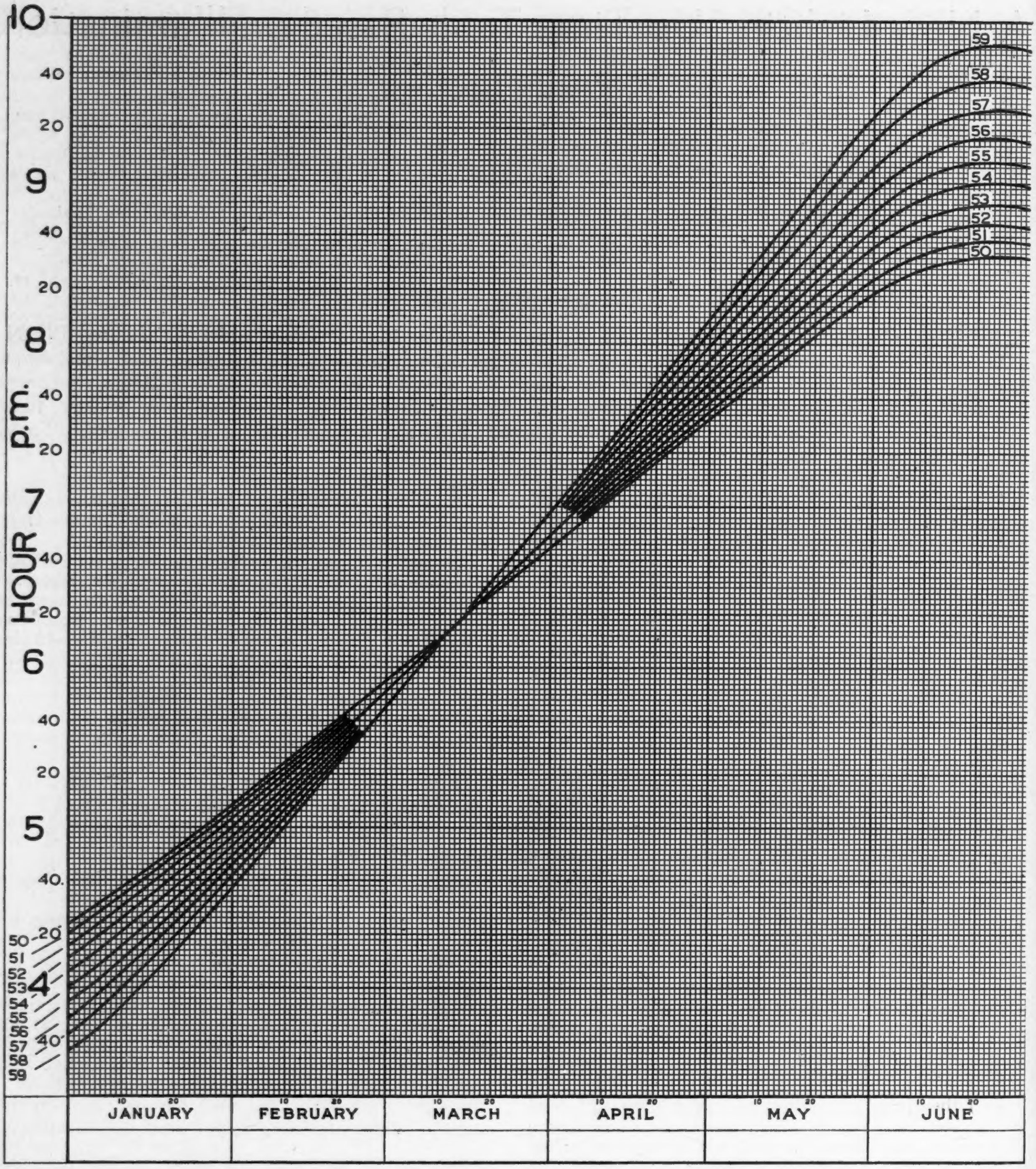
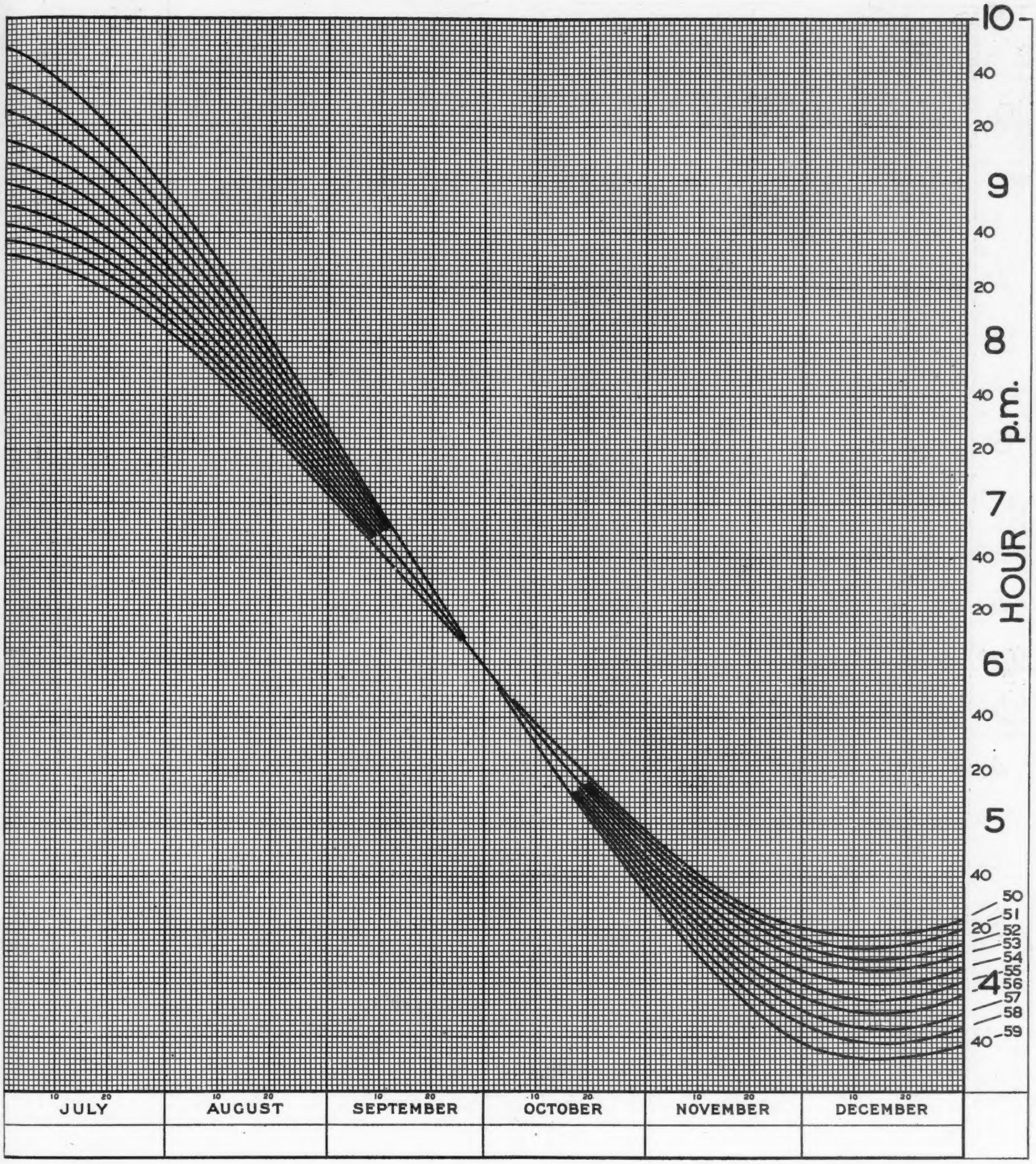


Figure 2. Curves of Lighting-Up Time throughout the Year for

PRACTICAL DETERMINATION OF THE SUN'S POSITION WHEN STREET LIGHTING IS REQUIRED.

On a day when the sky is completely overcast, the daylight illumination will be lower than when the sky is clear. The time-switch cannot take account of the weather, and it is necessary, therefore, to decide for which type of weather it should be set. In view of the fact that public lighting is required as a substitute for daylight, it would appear wise to make provision for the worst conditions. If the lighting time is decided on an overcast day, in clear weather the street lighting may be turned on a few minutes before it is required, but this appears preferable to choosing a later time, which would mean that in bad weather the lighting would not come on until too late. The observations made in the course of this investigation were as follows:—

Preliminary trials in January and February, 1933, showed general agreement as to the time at which observers considered the street lighting was required. The variation at greatest was $\pm$ 5 minutes from the average of the observers' opinions. On February 7, 1933, the sky in the north of London was completely overcast and the evening as dull as any likely to occur.



Latitudes 50° N. to 59° N. Longitude of Greenwich. Figure 2.

Observations in a suburban side street on this day gave 5.15 p.m. as the time at which street lighting was required. The latitude of the place was 51° 34′ N., and the longitude 18′ W. This was the starting point for the calculations.

METHOD OF CALCULATING LIGHTING-UP AND EXTINGUISHING TIMES.

It is the sun's angular distance perpendicular to the horizon as seen from any place which decides the illumination at the place. This perpendicular distance for any point on the earth, is usually expressed as a "zenith distance," i.e., the angle in a vertical plane between (i) a line from the centre of the earth through the point on which the observer is standing to the zenith in the heavens overhead, and (ii) a line from the centre of the earth through the centre of the sun. This angle is shown for one position of the sun in Figure 1.

From data given in the Nautical Almanac, the sun's zenith distance for this time on February 7, 1933, can be shown to be 93° 15′. The method of calculation is the solution of the spherical astronomical triangle met with in problems of navigation. Re-solving the triangle with this zenith distance throughout the year gives a series of times, both morning and evening, at

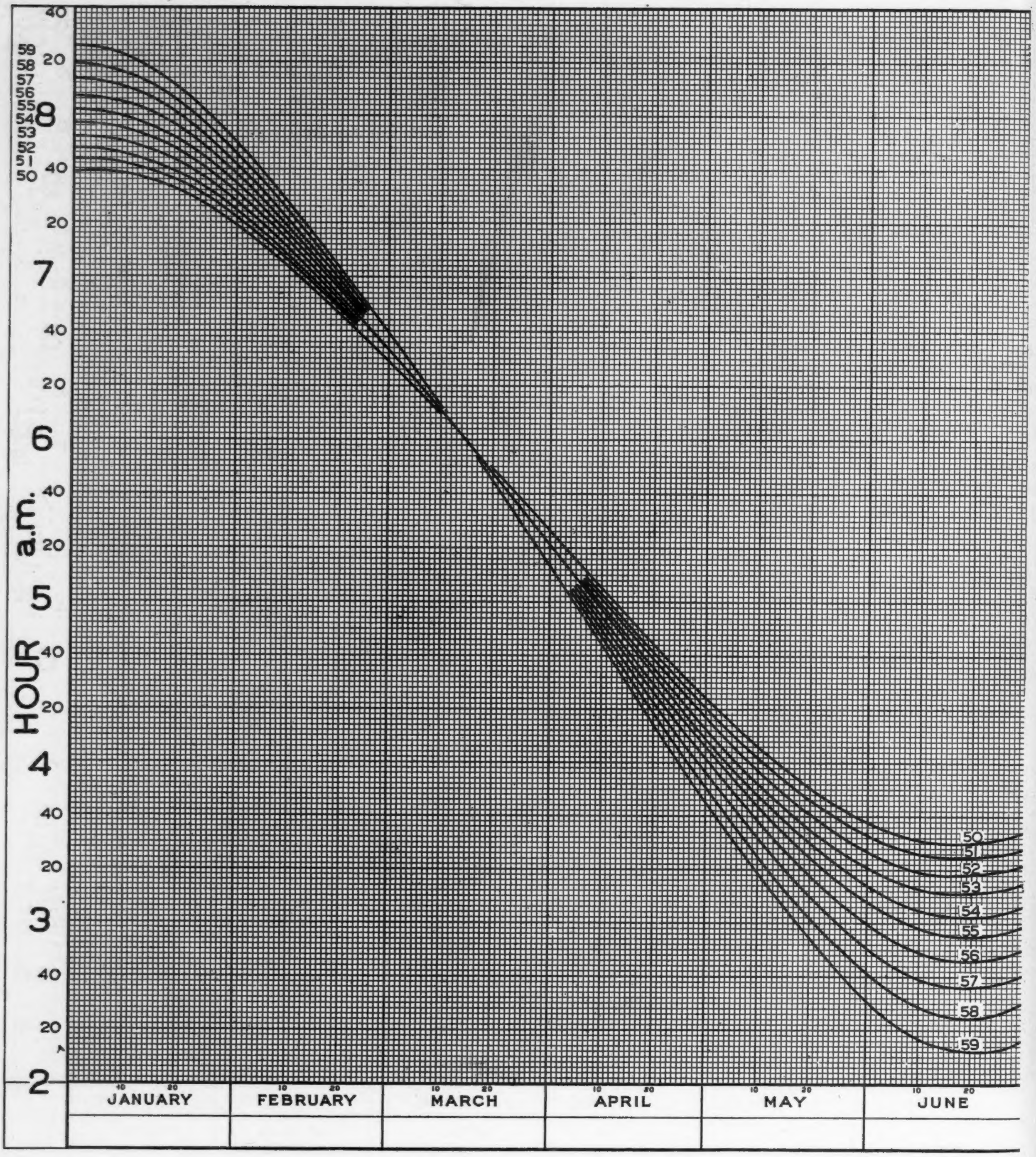


Figure 3. Curves of Extinguishing Time throughout the Year for

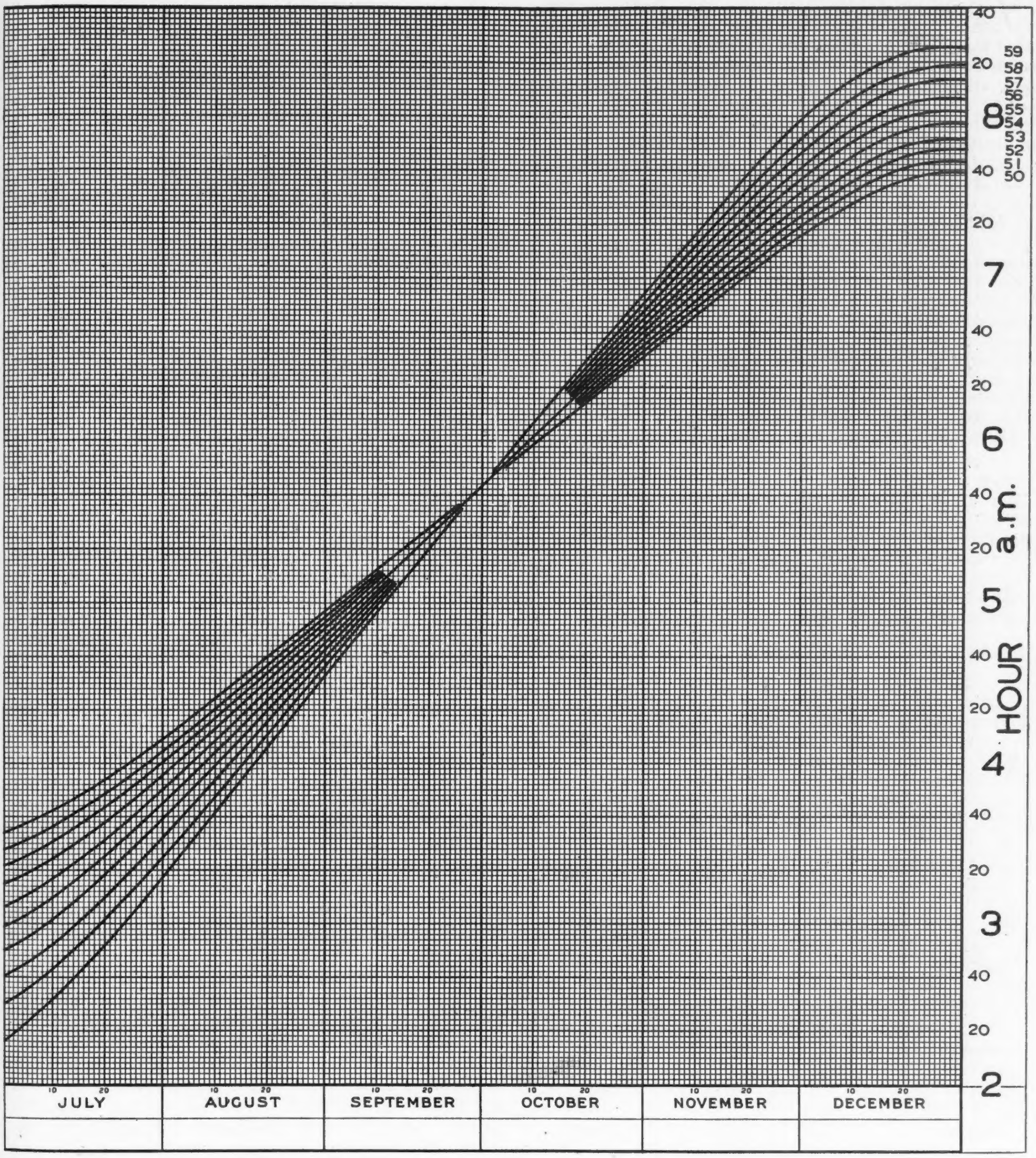
which, with an overcast sky, the daylight illumination will be the same as it was on February 7 when the first test was made. The times obtained will be solar times, and a correction must be made for the difference between solar and mean time. This is the Equation of Time which is tabulated in the Nautical Almanac. The calculations are laborious, but the problem has been reduced to its simplest terms by a series of simplifications suggested by Mr. J. W. Ryde, to whom the author is indebted for many other suggestions and for assistance with the calculations. The method is given in an appendix, so that calculations can be made for other latitudes or other values of the Sun's Zenith distance (i.e., for other daylight illumination values).

THE LIGHTING-UP AND EXTINGUISHING TIME TABLE AND CURVES.

The basic time table giving lighting-up and extinguishing times for every seventh day throughout the year is reproduced in Table 1*. For simplicity this table refers only to one point, that defined by the latitude 54° N. and the longitude of Greenwich†. The times given are Greenwich times. The times for

* See end of paper.

† It is actually a point off Flamborough Head, but that is of no consequence.



Latitudes 50° N. to 59° N. Longitude of Greenwich. Figure 3.

days of the year other than those tabulated may be determined by interpolation between the values given in Table 1, or they may be read off the curves in Figures 2 and 3 for latitude 54° N. These curves have been drawn from the data given in Table 1*.

Correction for Latitude: To enable the table to be used for any point in the British Isles (or in fact any point in the world lying between latitudes 50° N. and 59° N.), Tables 2 and 3 have been prepared. Table 2 gives the correction in minutes which must be added to or subtracted from the values in Table 1 to obtain the times at places situated on lines of latitude from 50° to 59° N. Instructions for use are given on the Table. From the data in Tables 1 and 2, a set of curves has been prepared, and these are given, for each degree of latitude, in Figures 2 and 3.

Correction for Longitude: The correction for longitude is quite simple to apply. As the sun's apparent movement across the heavens is from east to west, the more easterly a place is, the earlier is the lighting-up time, and the more westerly it is the later is the time. The tables have been calculated for the longitude of Greenwich, but there is a regular correction of 4 minutes per degree of longitude which can be applied. Places east of Greenwich require earlier

* It will be noticed that on the curves, February has 29 days, so that the times for this day in Leap Year may be obtained. In other years, this day should be disregarded.

times, and places west of Greenwich later times than those given by Tables 1 and 2. This correction is independent of latitude so that places having the same longitude but different latitudes, have the same correction. Further, it is a constant time correction to be added or substracted which does not vary from day to day, and is the same morning and evening. For convenience the correction for each degree of longitude from 2° E. to 10° W. of Greenwich has been calculated and the values are tabulated in Table 3.

Correction for Summer Time: Summer time involves the addition of 1 hour to the times given when daylight saving is in force. The dates for the next few years, during which this must be done, are given in Table 4.

For the majority of places, it will be sufficiently accurate to use the data (either Tables 1 and 2 or the curves) for the latitude nearest to the place under consideration, and to apply only the corrections for longitude and summer time if and when these are required. Where necessary it will be possible to construct accurately a new table or curve for any place which will remain correct for many hundreds of years. In practice, time-switches without astronomical mechanisms are usually reset once a week or once a fortnight and a full curve for every day in the year is not required. In such a case a table similar to Table 1, giving the times for every seventh day, but with the necessary corrections, will suffice. The switches can be set either to the time given for the beginning of the week or that for the end, depending on whether it is desired to err on the side of switching slightly early or slightly late.

EXAMPLE.

The following example will show the methods of interpolating from the tabular data and making the corrections. If the times for every seventh day only are required interpolation from Table 1 will not be necessary.

Required—Lighting-up and Extinguishing Times at Bristol on September 19. Bristol has an approximate latitude of 51½° N. and longitude 2½° W.

FROM TABLE 1.

		Extinguishing Time. a.m.	Lighting-up Time. p.m.
	September 16th	5.18	6.33
	„ 23rd	5.30	6.16
Interpolating for ...	„ 19th	5.23	6.26

FROM TABLE 2.

Correction for latitude. Take	51°N.	Add	0.03	Subtract	0.03
nearest date to Sept. 19th or	52°N.	„	0.02	„	0.02
interpolate.	51½°N.	„	0.03	„	0.03

to nearest minute.

FROM TABLE 3.

Correction for longitude 2½°W.—add 10 minutes.

FROM TABLE 4.

Correction for Summer Time—add 1 hour.

RESULT.		Extinguishing Time. a.m.		Lighting-up Time. p.m.
Table 1.	Sept. 19—Lat. 54°N.	5.23		6.26
Table 2.	Add	0.03	Subtract	0.03
		5.26		6.23
Table 3.	Add	0.10	Add	0.10
		5.36		6.33
Table 4.	Add	1.00	Add	1.00
	Required Times	6.36		7.33

During the Conference at Aberdeen the lighting-up times from the tables for September 17 to 20 inclusive are 7.42 p.m., 7.39 p.m., 7.37 p.m., and 7.34 p.m.

EFFECT OF LOCAL CONDITIONS.

In localities which are particularly dark, due to high buildings erected very close together or to a smoky atmosphere, it will be desirable to light street lamps earlier, and extinguish them later than the times given in the tables or curves. In theory, the extra time allowance will not be a constant quantity, but, as a first approximation, one figure may be taken for the whole year.

The value of the interval should be determined experimentally by comparing, on three or four overcast days as near together as possible, the difference between the lighting-up time as given in or calculated from the tables or curves and the time at which it appears desirable for lighting to be employed. The average of these three or four times can be used as the correction for the locality in question.

If greater precision is required, the tables can be recalculated by the method given in the appendix for the time obtained by observation. Alternatively, a fairly close approximation can be made by finding, for the days on which the correction is observed, the proportion of the interval between sunset and the lighting-up time given by these tables which is represented by the correction observed. The daily correction throughout the year will then be closely the same proportion of the daily interval between sunset at the place and the lighting-up time given by the tables in this paper.

PRACTICAL VERIFICATION.

As soon as the tables had been constructed, a daily check was made to determine how well the recommended times agreed with those at which observers considered public lighting was required. On dull days the difference was seldom more than ± five minutes, and on bright days the time was not more than ten to fifteen minutes early. There was no evidence to suggest that the proposals required any modification.

It should be noted that the interval between sunset or sunrise and the proposed lighting-up and extinguishing times is not constant. In latitude 54° N., for example, at midwinter and midsummer, the interval is twenty-two minutes, but at the equinoxes, in March and September, it is only sixteen. There is a gradual change from one day to the next. At higher latitudes the difference between extreme values of the interval is greater. From this it will be clear that the method adopted for defining the compulsory lighting-up time of vehicles' lights bears no relation to the requirements. In winter, the time is half an hour after sunset, and when " Summer " Time comes into force there is an abrupt change to an hour after sunset. It has been shown that if the lighting is to be based on illumination requirements, the longer intervals between sunset and lighting-up time should be used both in mid-summer and mid-winter, and it is between these dates that the shorter interval is required. A lighting-up time-table for public lighting, based on the addition of a constant interval of time after sunset throughout the year, would suffer from the same kind of defect as the statutory timetable, but to a less degree. A test made at Wembley on May 17, 1934, a light evening with little cloud, showed that thirty-two minutes before the statutory lighting-up time, 60 per cent. of motorists had their lights on, and, seventeen minutes before, every

motorist had them on. The lighting-up time suggested by the new tables was thirty-nine minutes before the statutory time defined as one hour after sunset. In the interests of safety, the motorist had made his own decision as to when lighting was required, and had demonstrated the weakness of the statutory time.

From data kindly supplied by Mr. T. Wilkie, of Leicester, it has been possible to make an interesting comparison between the times given by the new tables and the times at which a light sensitive switching unit (selenium bridge type) operated. As the amount of cloud varies from day to day, the fluctuations in the curve for the light sensitive unit would be expected. There is, however, quite good agreement between the general shape of this curve and points which have been plotted from the tables of this paper (see Figure 4). The broken lines show the lighting times used for time-switch setting in Leicester.

It is of interest to know the approximate value of the daylight illumination obtaining at the time when

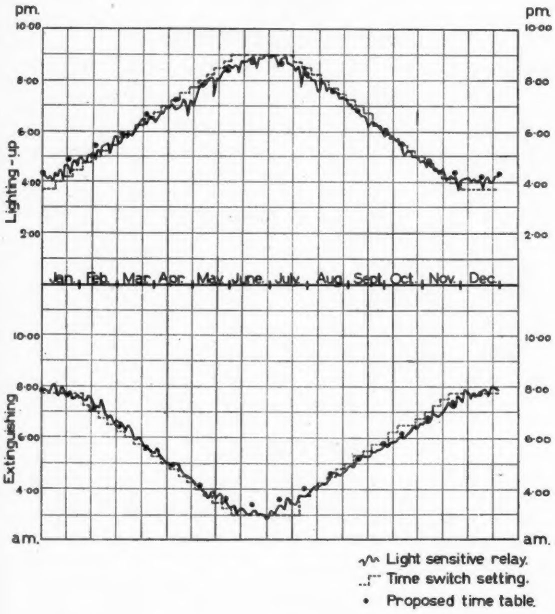


Figure 4. Lighting-up and Extinguishing Curve for Light Sensitive Switching Unit.

observers consider public lighting is required. This point was investigated by taking daylight readings on a horizontal test-plate, illuminated by an unobstructed hemisphere of sky, every few minutes near sunset time. The results are shown as a curve in Figure 5.

On this occasion, the lighting-up time by the tables was 9.08 p.m., when the daylight illumination had fallen to 4 foot-candles. A further measurement on an overcast day (the type of weather on which the tables are based) gave a value of 1 foot-candle at lighting-up time. In a street bordered by houses, the road surface is not illuminated by the whole hemisphere of sky on account of obstruction, and the illumination is therefore less than that obtaining at the same time in the open country. In the case of a suburban side street in Wembley, the illumination on the road surface near the kerb after sunset was 75 per cent. of that produced at the same time by an unobstructed hemisphere of sky. In a city street the proportion could easily fall as low as 30%.

NUMBER OF BURNING HOURS.

From the data given in the curves the number of burning hours per night has been determined. This information for latitude 54° N. has been summarised, and in Table 5 the total number of burning hours per month, per quarter, and per annum are given. At higher latitudes the total number of hours will be less and at lower latitudes more. The annual total in latitude 58° N. is approximately seven hours less than at latitude 54° N., and in latitude 50° N. it is approximately five hours more.

When controlled by the light sensitive unit referred to on page 363 and in Figure 4, the lamps burned for a total of 4,178 hours in the year, whilst with the time

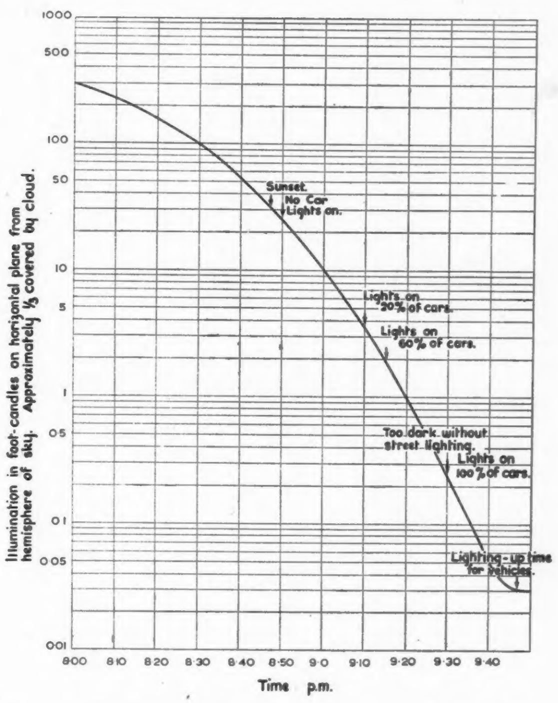


Figure 5. Daylight Illumination Readings on a Horizontal Test Plate from an unobstructed hemisphere of sky. Date May 17, 1934.

switch scale, shown in Figure 4, the total was approximately 4,000 hours.

ACKNOWLEDGMENTS.

Mr. H. W. Gregory, Monsieur J. W. Partridge, Mr. T. Wilkie, and Messrs. Wm. Sugg and Co., Ltd., were kind enough to supply lighting-up and extinguishing tables, which have provided interesting comparisons with the proposals made, and the author wishes to thank them for the data. It seems probable that the times used by Monsieur Partridge in Paris were derived by calculation from astronomical data.

The author also acknowledges with thanks the loan from Mr. P. J. Waldram of the diagram from which Figure 1 was made.

Table 1.

Lighting-up and Extinguishing Time Table for Latitude 54° N., Longitude of Greenwich.

Date.		Hour of Day. Extinguishing Time.	Hour of Day. Lighting-up Time.
		a.m.	p.m.
January	7	7.56	4.16
,,	14	7.52	4.27
,,	21	7.46	4.39
,,	28	7.37	4.51
February	4	7.24	5.04
,,	11	7.11	5.17
,,	18	6.57	5.30
,,	25	6.42	5.44
March	4	6.24	5.59
,,	11	6.09	6.13
,,	18	5.52	6.26
,,	25	5.36	6.39
April	1	5.19	6.52
,,	8	5.02	7.05
,,	15	4.46	7.18
,,	22	4.28	7.31
,,	29	4.11	7.44
May	6	3.56	7.57
,,	13	3.42	8.10
,,	20	3.30	8.23
,,	27	3.20	8.35
June	3	3.10	8.47
,,	10	3.05	8.55
,,	17	3.03	8.59
,,	24	3.04	9.00
July	1	3.08	8.58
,,	8	3.15	8.53
,,	15	3.24	8.47
,,	22	3.34	8.38
,,	29	3.46	8.26
August	5	3.59	8.13
,,	12	4.12	7.58
,,	19	4.26	7.42
,,	26	4.38	7.25
September	2	4.52	7.07
,,	9	5.04	6.50
,,	16	5.18	6.33
,,	23	5.30	6.16
,,	30	5.44	5.59
October	7	5.56	5.42
,,	14	6.09	5.25
,,	21	6.22	5.09
,,	28	6.35	4.54
November	4	6.48	4.40
,,	11	7.00	4.27
,,	18	7.12	4.16
,,	25	7.24	4.09
December	2	7.35	4.03
,,	9	7.44	4.00
,,	16	7.52	4.00
,,	23	7.56	4.01
,,	30	7.57	4.05

Table 3.
Longitude Correction.

Subtract or add to times from Tables 1 and 2.

Longitude.	Correction.
2° E. of Greenwich	Subtract 8 minutes
1° E. ,, ,,	,, 4 ,,
0°	0
1° W. ,, ,,	Add 4 ,,
2° W. ,, ,,	,, 8 ,,
3° W. ,, ,,	,, 12 ,,
4° W. ,, ,,	,, 16 ,,
5° W. ,, ,,	,, 20 ,,
6° W. ,, ,,	,, 24 ,,
7° W. ,, ,,	,, 28 ,,
8° W. ,, ,,	,, 32 ,,
9° W. ,, ,,	,, 36 ,,
10° W. ,, ,,	,, 40 ,,

Table 4.
Summer Time Correction.

For days between the following dates, add 1 hour to the times obtained from Tables 1, 2 and 3, i.e. time is 1 hour later.

Year.	Dates.
1934	April 22 2 a.m. to Oct. 7 2 a.m.
1935	,, 14 ,, ,, 6 ,,
1936	,, 19 ,, ,, 4 ,,
1937	,, 18 ,, ,, 3 ,,
1938	,, 10 ,, ,, 2 ,,
1939	,, 16 ,, ,, 8 ,,
Etc.	Etc. Etc.

APPENDIX.

Simplified Expressions for the Calculation of a Lighting-up and Extinguishing Time Table.

Let

λ = latitude,
δ = declination of sun,
z = zenith distance of sun,
h = hour angle of sun.

Also let

c = co-latitude = $90° - \lambda$.
and p = North Polar distance of sun $\left.\right\}$ = $90° - \delta$ North. $90° + \delta$ South.

Then it may be shown that

$$\cos h = \frac{A + B}{D}$$

where
$A = \cos(p + c) + \cos(p - c)$
$D = \cos(p + c) - \cos(p - c)$
$B = -2 \cos z.$

Now the tables given have been calculated for a value of $z = 93° \ 15'$. In this case the expression becomes $\cos h = \dfrac{A + 0.113.}{D}$ In localities in which the daylight illumination is reduced by smoke

Table 2.

Correction for Latitude of Place.

Correction to **lighting-up time** should be added to the times in Table 1 when the sign is + (i.e., time is later than that in Table 1) and subtracted when the sign is — (i.e., time is earlier than that in Table 1).

Correction to **extinguishing time** should be subtracted from the times in Table 1 when the sign is + (i.e., time is earlier than that in Table 1) and added when the sign is — (i.e., time is later than that in Table 1).

Date.	Correction in Minutes.										Date.
	North Latitude 50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	
January 7	+17	+13	+ 9	+ 5	0	− 5	−10	−16	−21	−28	January 7
,, 14	+16	+12	+ 9	+ 4	0	− 4	− 9	−15	−20	−26	,, 14
,, 21	+14	+11	+ 8	+ 4	0	− 4	− 8	−13	−18	−23	,, 21
,, 28	+12	+10	+ 7	+ 3	0	− 3	− 7	−11	−15	−21	,, 28
February 4	+11	+ 8	+ 6	+ 3	0	− 3	− 6	− 9	−13	−17	February 4
,, 11	+ 9	+ 7	+ 5	+ 2	0	− 2	− 5	− 8	−11	−14	,, 11
,, 18	+ 7	+ 5	+ 4	+ 2	0	− 2	− 4	− 6	− 9	−11	,, 18
,, 25	+ 5	+ 4	+ 3	+ 1	0	− 1	− 3	− 4	− 6	− 7	,, 25
March 4	+ 3	+ 2	+ 1	+ 1	0	− 1	− 1	− 2	− 4	− 4	March 4
,, 11	+ 1	+ 1	0	0	0	0	0	− 1	− 1	− 2	,, 11
,, 18	0	0	0	0	0	0	0	+ 1	+ 2	+ 2	,, 18
,, 25	− 3	− 3	− 1	− 1	0	+ 1	+ 1	+ 3	+ 4	+ 5	,, 25
April 1	− 5	− 4	− 2	− 1	0	+ 1	+ 2	+ 5	+ 6	+ 8	April 1
,, 8	− 7	− 5	− 4	− 2	0	+ 2	+ 4	+ 7	+ 9	+12	,, 8
,, 15	−10	− 7	− 5	− 2	0	+ 2	+ 6	+ 9	+12	+15	,, 15
,, 22	−12	− 9	− 6	− 3	0	+ 3	+ 7	+11	+15	+19	,, 22
,, 29	−14	−11	− 7	− 4	0	+ 4	+ 8	+13	+18	+23	,, 29
May 6	−16	−12	− 8	− 4	0	+ 4	+10	+16	+21	+27	May 6
,, 13	−18	−14	− 9	− 5	0	+ 5	+11	+18	+25	+31	,, 13
,, 20	−20	−16	−11	− 5	0	+ 5	+13	+20	+28	+35	,, 20
,, 27	−23	−18	−12	− 6	0	+ 6	+14	+22	+31	+40	,, 27
June 3	−24	−19	−13	− 7	0	+ 7	+15	+24	+34	+44	June 3
,, 10	−26	−21	−14	− 7	0	+ 7	+16	+26	+36	+48	,, 10
,, 17	−27	−21	−15	− 8	0	+ 8	+17	+27	+38	+50	,, 17
,, 24	−27	−21	−15	− 8	0	+ 8	+17	+27	+38	+51	,, 24
July 1	−26	−20	−14	− 8	0	+ 8	+16	+26	+36	+50	July 1
,, 8	−25	−20	−14	− 7	0	+ 7	+16	+25	+35	+46	,, 8
,, 15	−23	−18	−12	− 7	0	+ 7	+14	+23	+32	+42	,, 15
,, 22	−22	−16	−11	− 6	0	+ 6	+13	+21	+29	+38	,, 22
,, 29	−19	−15	−10	− 5	0	+ 5	+12	+19	+26	+33	,, 29
August 5	−17	−13	− 9	− 5	0	+ 5	+10	+16	+23	+30	August 5
,, 12	−15	−11	− 8	− 4	0	+ 4	+ 9	+14	+20	+25	,, 12
,, 19	−13	−10	− 7	− 3	0	+ 3	+ 8	+12	+17	+21	,, 19
,, 26	−11	− 8	− 6	− 3	0	+ 3	+ 7	+10	+14	+17	,, 26
September 2	− 8	− 6	− 4	− 2	0	+ 2	+ 5	+ 8	+10	+13	September 2
,, 9	− 6	− 4	− 3	− 2	0	+ 2	+ 4	+ 6	+ 7	+ 9	,, 9
,, 16	− 3	− 3	− 2	− 1	0	+ 1	+ 2	+ 4	+ 5	+ 7	,, 16
,, 23	− 2	− 2	− 1	− 1	0	+ 1	+ 1	+ 2	+ 3	+ 3	,, 23
,, 30	0	0	0	0	0	0	0	0	0	0	,, 30
October 7	+ 2	+ 2	+ 1	0	0	0	− 1	− 2	− 2	− 3	October 7
,, 14	+ 4	+ 3	+ 2	+ 1	0	− 1	− 2	− 3	− 5	− 6	,, 14
,, 21	+ 6	+ 5	+ 3	+ 1	0	− 1	− 3	− 5	− 8	− 9	,, 21
,, 28	+ 8	+ 6	+ 5	+ 2	0	− 2	− 5	− 7	−10	−13	,, 28
November 4	+11	+ 8	+ 6	+ 2	0	− 2	− 6	− 9	−12	−16	November 4
,, 11	+12	+ 9	+ 7	+ 3	0	− 3	− 7	−11	−15	−19	,, 11
,, 18	+13	+10	+ 8	+ 4	0	− 4	− 8	−12	−17	−22	,, 18
,, 25	+15	+11	+ 8	+ 4	0	− 4	− 8	−14	−19	−25	,, 25
December 2	+17	+12	+ 9	+ 5	0	− 5	−10	−15	−20	−27	December 2
,, 9	+18	+13	+ 9	+ 5	0	− 5	−10	−16	−22	−27	,, 9
,, 16	+18	+14	+ 9	+ 5	0	− 5	−10	−17	−22	−28	,, 16
,, 23	+18	+14	+ 9	+ 5	0	− 5	−10	−17	−22	−28	,, 23
,, 30	+18	+14	+ 9	+ 5	0	− 5	−10	−17	−22	−28	,, 30

or obstructions, a smaller value of z may be desirable. This value can be determined experimentally and the expression $\cos h = \frac{A + B}{D}$ solved for B, for an observed value of h (the hour angle of the sun at the time of observation). The calculations of desirable lighting-up and extinguishing times for the given place on various days can then be made, using this new value for z.

Table 5.

Number of Burning Hours for Lamps operating to New Time Table at Latitude 54° N.

Month	Hours of Burning						Month
	Lighting-up Time to Midnight			Midnight to Extinguishing Time			
	per month	per quarter	per annum	per annum	per quarter	per month	
January	231.9					242.1	January
February	190.9*	597.5*			630.7*	204.2*	February
March	174.7					184.4	March
April	140.5					142.0	April
May	115.9	348.5			347.4	112.6	May
June	92.1					92.8	June
			2023*	2027*			
July	101.5					106.8	July
August	130.2	394.5			399.4	134.3	August
September	162.8					158.3	September
October	206.2					192.7	October
November	229.1	682.6			649.2	214.0	November
December	247.3					242.5	December
Total per annum			4050*				

* These figures have been computed assuming that February has 29 days as in a Leap Year. For other years subtract 6.1 hours from the number of hours to midnight and 6.5 hours from the number after midnight. No allowance has been made for Summer Time.

FULLY WORKED EXAMPLE.

Required: Lighting-up and Extinguishing Times (at which sun's zenith distance is 93° 15′) for April 28 in latitude 53° N., longitude of Greenwich.

Latitude = 53° N.

Sun's declination: The value of the sun's declination which should be used for the calculation of extinguishing time is that occurring at that time. The sun's declination, however, is not constant at a given time on a given day in every year on account of the difference in length between a solar and a calendar year. For example, at sunrise on April 28 from 1932-1935 inclusive, the declination was or will be 14° 05′ N., 14° 00′ N., 13° 55′ N., and 13° 50′ N. The leap year corrects for the discrepancy in length between the solar and calendar years, and so the extreme variations are never likely to exceed those for the four years given above.

In the example which follows, the value of the sun's declination used is the mean value occurring at sunrise over the four years.

= 13° 57′ N.

Hence $c = 37°$ $\quad p + c = 113°\ 3'$

$p = 76°\ 3'$ $\quad p - c = 39°\ 3'$

$\cos(p+c) = \cos 113°3' = -\sin 23°3' = -0.392$

$\cos(p-c) = \cos 39°3' = +0.777$

$D = -1.169$

$A = 0.385$

$B = 0.113$

$A + B = 0.498$

$\log A + B = \bar{1}.6972$

$\log D = 0.0679$ negative

Hence $\log \cos h = 1.6293$ negative

$\cos h = -0.4259$

$h = 90° + \sin^{-1} 0.4255$

$= 115°\ 12'$ of arc

$= 7^h\ 40.8^m$ in time

From Nautical Almanac: Mean Equation of Time (the small variation is averaged over four years), $E = 2.5^m$.

$12 - h = 4^h\ 19.2^m$

$- E = 2.5^m$

$12 - h - E = 4^h\ 16.7^m$

Therefore required extinguishing time to nearest minute = $4^h\ 17^m$ a.m.

For the calculation of lighting-up time the mean value of sun's declination at sunset should be used to obtain the same accuracy as with the calculation for extinguishing time. It is more convenient, however, to use one value of the declination for the calculation of both lighting-up and extinguishing times, and if the average value over four years of the sun's declination at noon is used instead of the values for sunrise and sunset, the error will never be greater than two minutes. It is the average noon values which have been used for the calculations of the tables in the paper.

DISCUSSION

Mr. P. Richbell (Croydon) expressed appreciation of the fact that Mr. Wilson had provided a time-table which had been calculated on a scientific basis, and remarked that recent enquiries had revealed great variations in lighting-up times in various towns.

Mr. E. J. Stewart (Glasgow) said he had been taking records for a number of years regarding lighting-up times, and proposed to plot Mr. Wilson's figures against his own and let him have the result. Incidentally, Mr. Stewart emphasised the need for efficient maintenance of lighting installations, remarking, that whilst every endeavour was made to put in the best possible equipment, there was not always the same care taken in subsequent maintenance. Mr. Stewart asked how Mr. Wilson had decided when the lights should be lighted in his early experiments, and stated that in Glasgow one basis adopted was when the lighting definitely aided the visibility of objects.

Mr. E. C. Lennox commented on the great variation in lighting-up times in various towns, and said that although considerable trouble had been taken in the preparation of the British Standard Specification for street lighting, hours of burning in various towns and in the schedules of various authorities in one town, varied as much as 10 per cent. With these variations, it was quite impossible for quotations to be on a common basis. In his own case on the north-east coast they had a lighting-up schedule which followed the sun to some extent but account was also taken of observations that were continually being made. Actually, this time-table differed from Mr. Wilson's to the extent of from 5 to 10 minutes in the winter time—when he switched on earlier than Mr. Wilson—and from 20 to 55 minutes in the summer, when he switched on later than Mr. Wilson. Personally, he did not think the author had made sufficient allowance for increased clarity in summer time.

Mr. J. F. Colquhoun (Sheffield), whilst expressing his willingness to accept the author's time-table, said it was a matter of £ s. d. in regard to its application in Sheffield. If the author's time-table was adopted there it would mean the necessity for a further twenty million cubic feet of gas and 250,000 units of electricity, because at the present time there were 330 hours less lighting in Sheffield per annum than would be the case under the author's time-table. In his view, that extra amount of lighting should be afforded, and he expressed the hope that local authorities would regard the problem of sufficiency of street lighting with greater sympathy in the future, notwithstanding the extra cost, because it conduced to safety in all directions. Mr. Colquhoun showed a slide of the fog distribution in Sheffield, and suggested that it would be necessary in such a situation to use different lighting-up times in different parts of the city. He thought this might prove a difficulty.

Mr. Wilson said, in reply to Mr. Stewart, that the basis on which the lighting-up time was first decided was similar to that described by Mr. Stewart, namely, when the lighting produced noticeably light regions in the road against which objects were more clearly seen than by the failing daylight. In reply to Mr. Lennox, Mr. Wilson said that if he could be supplied with curves showing the rate of fall in Newcastle under various weather conditions, he could work out the lighting-up time by his method and see how it compared with the times given in the paper. Mr. Colquhoun was concerned with this point also, and Mr. Wilson said that he could also make calculations for Sheffield if he had data on daylight illumination. He thought, however, that as the fall in daylight illumination was so rapid near lighting-up time, from 5 to 1 in 10 minutes, that the effect of fog would only make a few minutes difference to the desirable lighting-up times. Mr. Wilson concluded by saying that only experience would confirm the tables or suggest modifications, and that he would like to have the views of lighting engineers after they had used the tables for twelve months.

Lighting Department Practice and Equipment (Discussion)

In the discussion of the above paper by Mr. J. M. Ward and Mr. J. Mann, which appeared in our last issue,* The President complimented Glasgow on the example set by their Department. In Aberdeen, however, when damage was caused to lamps and standards by motor vehicles the full value was claimed. In Aberdeen underground cables for street lighting had been abandoned, owing to the greater cheapness and ease of repair of overhead systems.

Mr. J. F. Colquhoun (Sheffield) referred to the control board dealing with 200 electric lights, apparently spread over 24 34½ miles. In the event of fog on say 4 miles of streets would it be necessary to light lamps on the whole 34 miles? The graph showing the relation between rainfall and lamp renewals should be of great assistance to manufacturers.

Mr. F. A. C. Pykett (Coventry) asked for details of the mantle used for stair lighting and stated to consume only 0.7 cubic feet of gas per hour.

Mr. J. Sellars (Manchester) said that it had been asserted that the life of overhead cables did not exceed 15 to 25 years, as compared with 40 years for a well-laid underground cable and that maintenance costs were higher. Had the authors any experience of electrolytic trouble?

Mr. A. W. Barham (Watford) remarked that from experience of underground cables in Watford, a life of 60 years might well be expected. With protection against stray currents any trouble due to electrolysis had been overcome.

Mr. J. K. Brydges (Eastbourne) mentioned the successful introduction, on a large housing estate in Liverpool, of a system of multiple (stronger) control which appeared to have certain advantages over the selenium cell system. He enquired whether any members had experience of this system.

Mr. R. E. Rogers (Liverpool) said that in Liverpool two housing estates, one with 560 and the other with 300 lamps, were being operated by remote control, Originally there had been some trouble with the overhead wiring system, but this had been overcome. There seemed great scope for this system in operating street lighting.

Captain W. J. Liberty (London) stated that in the City of London all cables were underground and were laid in 1900. No trouble had since been experienced. He recalled that a private Act of 1848 empowered the City to place fixtures on the walls of houses—an important consideration in connection with central suspension.

Mr. F. C. Smith (London) emphasised the importance of public lighting being under expert control. In the case of gas lighting mains were necessarily underground. A special form of protection against electrolysis had been evolved. In regard to the mantle-shocking machine illustrated in the paper he would like to know the size of the weight and the distance it fell, also the nature of the sideways movement. In the machine with which he was familiar 1,000 shocks could be given, but 500 usually furnished a sufficient test.

Mr. C. E. Allsopp (Bradford) said that of the 90 miles of street lighting in Bradford, 70 was overhead, and some dated back for 20 years. No failures of importance had since occurred. Overhead cables had certain advantages, e.g., freedom from possible interference when excavation work was in progress, though when cost was not vital underground cables should certainly be considered.

Mr. J. Mann, replying to the discussion, explained that in Glasgow the special arrangement in regard to damage ensured no claims being disputed. In Glasgow, an industrial city, some fog was not unusual, but it was not frequently dense fog and might be merely mist. In the event of a local fog it was possible to operate certain districts, if necessary, by hand. He was a little disappointed that so much discussion had been devoted to the merits of overhead and underground systems. In Glasgow the former was considerably the cheaper. Mr. Langlands would be pleased to give facilities for the inspection of the mantles described. The system mentioned by Mr. Brydges was quite distinct from that used in Glasgow.

Mr. J. M. Ward mentioned that on certain housing estates near Glasgow the special nature of the soil and resultant corrosion had made overhead wiring imperative.

* Illum. Eng., Oct., 1934, p. 293.

Some Notes On The Lighting Exhibits at Aberdeen

HELD AT THE MUSIC HALL BUILDING DURING SEPTEMBER 17th—20th, 1934

A BRIEF account of this Exhibition, in which 18 firms participated, was given in our last issue. It is now proposed to deal with some individual exhibits; these may be divided into three main divisions, gas lighting, electric lighting and lighting control.

The exhibit of HOLOPHANE LTD., included both gas and electric fittings. A feature of the exhibits utilised with gas lighting was an entirely new form of panel type lantern—the "Holgas" lantern (see p. 375)—employing *Holophane Refractor glass panels,* which was shown for the first time. This fitting has been designed in collaboration with the leading Gas Lantern Manufacturers and the Research Department of the Gas Light and Coke Co., Ltd. The burners used are of a staggered line formation. The prismatic panels are designed to give directional lighting at 150° or 180°, as required.

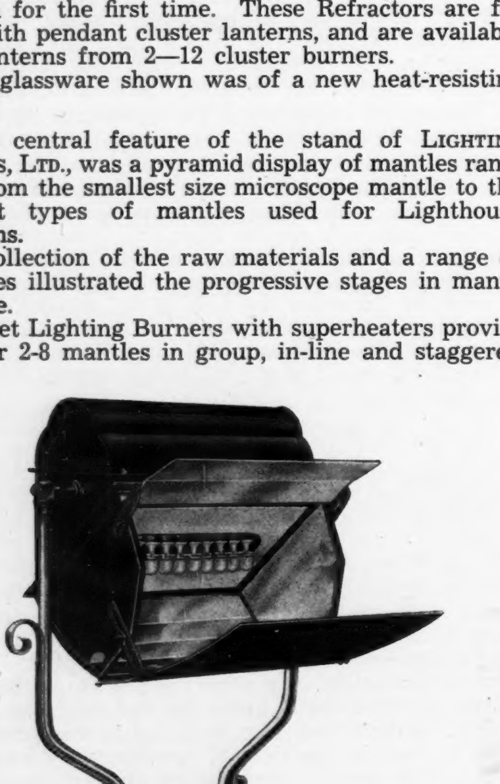
A full range of the *Gas Dish Refractors* was also shown for the first time. These Refractors are for use with pendant cluster lanterns, and are available for lanterns from 2—12 cluster burners.

All glassware shown was of a new heat-resisting type.

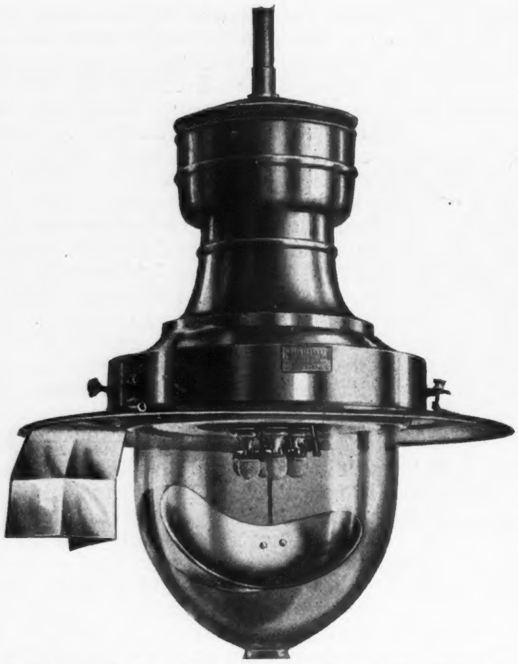
The central feature of the stand of LIGHTING TRADES, LTD., was a pyramid display of mantles ranging from the smallest size microscope mantle to the largest types of mantles used for Lighthouse Beacons.

A collection of the raw materials and a range of mantles illustrated the progressive stages in manufacture.

Street Lighting Burners with superheaters providing for 2-8 mantles in group, in-line and staggered formation, fitted with the *Renown* Magnesia Superheaters, which do not use or need gauzes or perforated discs, and entirely overcome the corrosion problem were on view.



Parkinson Upward Beam Flood-Lite Alignment Lamp.



Parkinson Mor-Lite Gas Lamp with Curved Top Reflector.

An interesting item was the display of a series of mantles containing varying percentages of ceria and thoria. The "daylight" mantles attracted special attention and gave the impression of being surprisingly efficient for a light of this character.

The exhibits of MESSRS. W. PARKINSON AND Co. included:—

(1) An 18″ square lantern, fitted with 4 light alignment burner (No. 2 Mantles) and a combination of Mor/lite and Curved Top Staybrite Steel Reflectors. By means of this a wide beam of high intensity is produced at a low angle from the horizontal, and a maximum candle power of over 700 obtained. This lamp is capable of maintaining classification F, and even E, of the British Standard Specification for Street Lighting, for normal spacings and mounting heights. The lamp was mounted on a Cornolith lamp column, of an artificial conglomerate, imitating a Cornish granite, which it rivals in strength and durability.

(2) The *Parkinson* Lamp Selection Chart, copies of which were available on request, and which enables Lighting Engineers to choose the particular Square lantern suitable for normal Street Lighting Schemes.

(3) The *Rotherham* Lamp, consisting of a 6-light cluster burner (No. 2 Mantles) in a suspension lamp and fitted with special parabolic reflectors inside the bowl. A maximum candle power of 1200 was obtainable with this lamp.

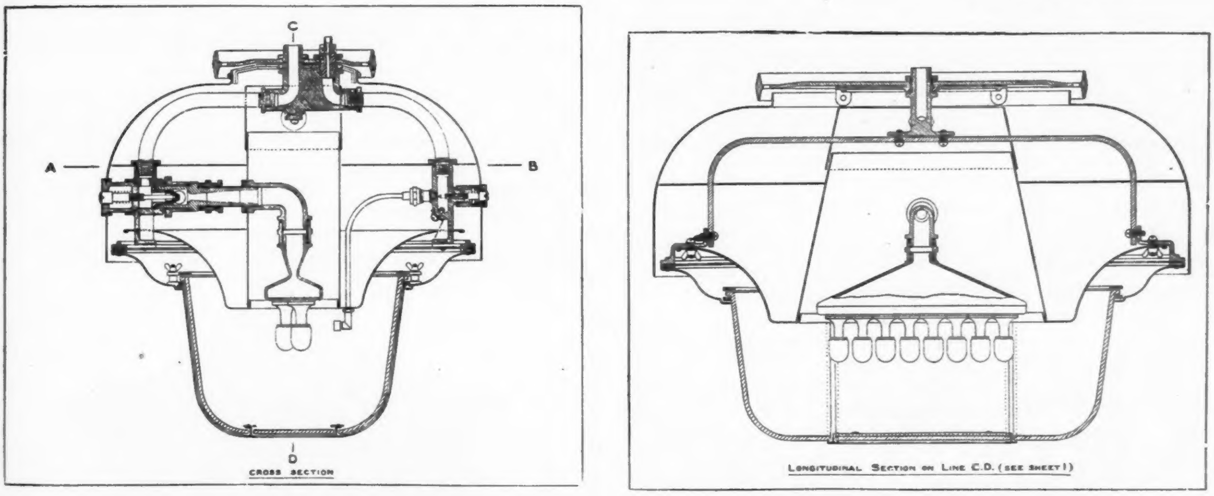
(4) The *Upward Beam Alignment Flood-lite Lamp,* comprising 10-light burner (No. 2 Mantles), and fitted with a slatted back reflector of parabolic section. (The value of this lamp for the floodlighting of buildings, gardens, etc., was clearly shown in an attractive booklet entitled "Floodlighting by Gas.")

Interesting features at the Exhibition were sinusoidal diagrams representing the candle power distribution of these and other typical lamps, and iso-lux diagrams showing their performance of street lighting units.

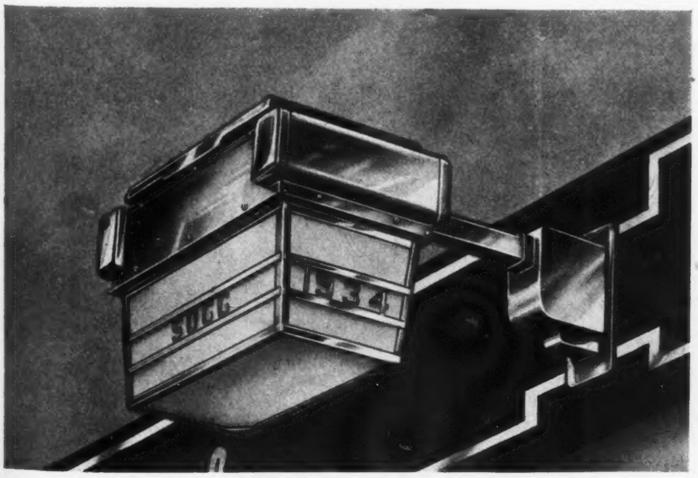
The exhibits of WILLIAM SUGG AND Co., LTD., included a new type of lamp, specially designed for shop front lighting, in connection with which it is

A General View of the new "Holgas" Panel Type Gas Lighting Unit, as used in Chapel Street, Aberdeen.

Day View of Chapel Street, where the units of the type shown in the adjacent illustration were installed by the Gas Light and Coke Company. (A Night View of this installation appeared in our last issue, page 289.)



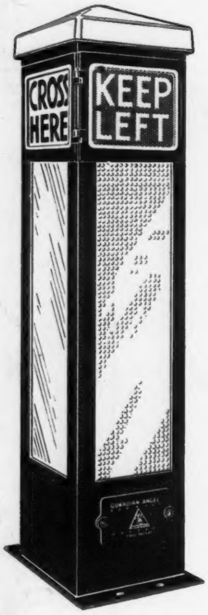
Details of the new "Holgas" Panel Type Gas Lighting Unit, a general view of which appears above.



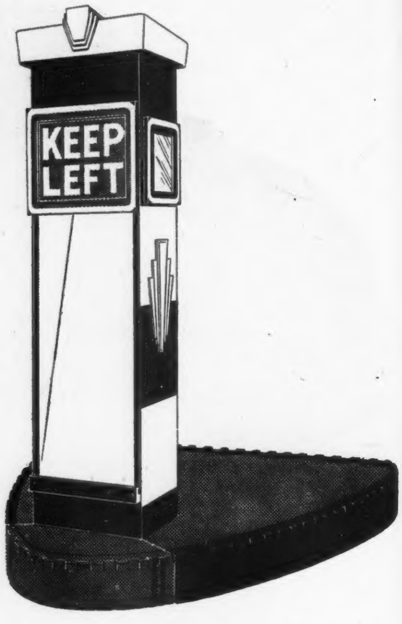
A View of the original "Arcade" fitting which formed a feature of the exhibit of Messrs. William Sugg and Co., Ltd.

One of the Projectors, equipped with 400 watt Mazda Mercra Lamp, which served to floodlight the Marischal College. (This striking installation was also illustrated in our last issue, page 289.)

The Belford II. Lantern (Falk Stadelmann and Co., Ltd.).



The "Arc Angel" 4-way Illuminated Guard Post.



The "Guardian Angel" Minor Single Way Guard Post.

(Exhibits of Gowshall, Ltd.).

possible to display the name of the shop in metal letters, which, being chromium-plated, constitute a good advertisement by daylight, and, at night, when the lamp is in lighting, are silhouetted against an opal glass background. The lamp itself, together with projecting arm, is finished in chromium plate, and is designed to conform with the stainless steel shop fronts, which are now so greatly in demand. (See page 375). In conjunction with Messrs Edgar, the *"Holgas" lamp,* alluded to above, was also shown.

The exhibit of Falk Stadelmann and Co., Ltd., included both Gas and Electrical Appliances. Amongst the electric lighting exhibits are the *"Melton"* and *"Gosport"* Lanterns, and the *"Belford II.,"* with square Pearlstone 3-ply Globe, which forms an attractive combination.

The *"Veritas" Internalite* Plate Glass *Gas Sign,* fitted in the Stand, and inscribed *"Enquiries,"* and the *"Veritas" Animated Gas Sign* were shown in operation.

Street Lighting Burners of the firm's manufacture were shown in various multiples, together with Directional Reflectors, and there was a comprehensive range of the familiar *"Veritas" Mantles.*

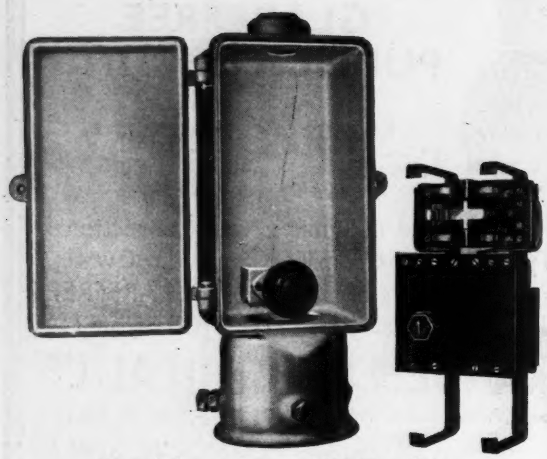
Foster and Pullen, Ltd., displayed square lamps with various types of burners, stainless steel reflectors, inverted lanterns specially designed for ease of maintenance, U bracket lamps of new design, and accessories generally required for the illumination of streets.

In addition, units for the floodlighting of buildings and photographs of installations were shown.

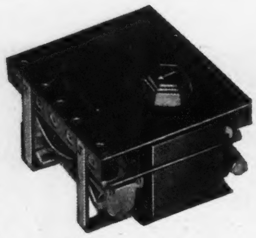
Traffic devices, a new section of special interest to the public lighting engineer, were well represented at the stalls of The Automatic Light-Controlling Co., Ltd., and Gowshall, Ltd. The exhibit of the former included electric time switches with synchronous movement, quick action gas controllers, and illuminated guard posts—of which specimens are illustrated above. Gowshall, Ltd., displayed the familiar *"Guardian Angel," "Arc Angel,"* and *"Sentry"* illuminated guard posts, and a fine selection of internally illuminated mandatory signs, etc. A new exhibit was the *"Guardian Angel White Knight"* post, which is equipped with a special patented reflector, focussing the light of two 40-watt lamps on to the reflecting surfaces. The very efficient warning thus afforded is obtained with relatively low current consumption. (All these posts, it may be noted, are suitable for either gas or electric illumination.)

Electric lighting equipment was very well represented. In addition to the "Holgas" lantern noted above, Holophane, Ltd., showed a special square type lantern, with an ingenious design of prisms on the prismatic plates, to suit the Electric Discharge lamp, specially designed for side of street mounting, the *Duo-Dome* series of refractors and lanterns, and a full range of the standard type Bowl Refractors.

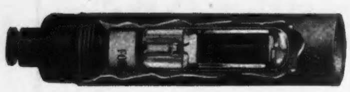
Siemen's D.A.4 (top) and D.B.2 (bottom) lanterns for use with Sieray Electric Discharge Lamps. A feature of the latter is the flexibility of the arrangements for directional control.



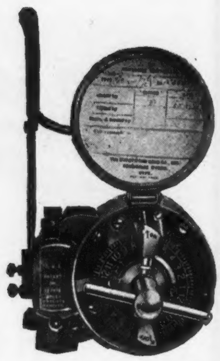
General Arrangement of 1,500 Watt Unit.



500 Watt Unit.



Bridge housing with bridge inserted.



Newbridge Catalytic Torch Ignition Controller (Horstmann Gear Co., Ltd.)

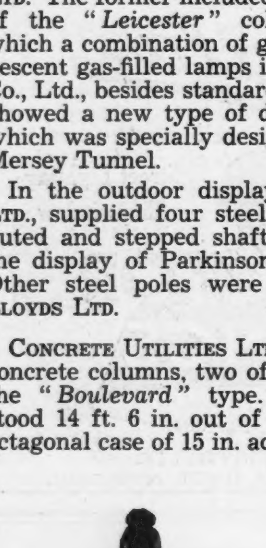
Parts of the new Radiovisor Light-Actuated Control.

Electric Discharge Lamps and Lanterns figured largely in the exhibits of the British Thomson-Houston Co., Ltd., the Edison Swan Electric Co., Ltd., the General Electric Co., Ltd., and Siemens Electric Lamps and Supplies, Ltd. As regards the lamps themselves, special interest was taken in two items, shown for the first time, the 250-watt lamp (now furnished by several firms), and the horizontal lamps, for which the B. T.-H. were responsible, giving improved facility of control of distribution of light.

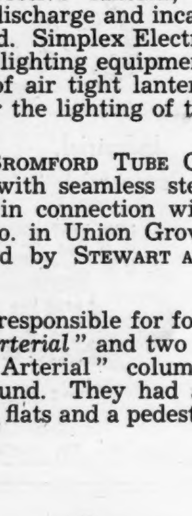
Special lanterns were shown by, amongst others, Revo Electric Co., Ltd., and Simplex Electric Co., Ltd. The former included in their exhibit a specimen of the "*Leicester*" colour-corrective lantern, in which a combination of gaseous discharge and incandescent gas-filled lamps is utilised. Simplex Electric Co., Ltd., besides standard street lighting equipment, showed a new type of dust-proof air tight lantern, which was specially designed for the lighting of the Mersey Tunnel.

In the outdoor display the Bromford Tube Co. Ltd., supplied four steel poles, with seamless steel fluted and stepped shafts, used in connection with the display of Parkinson and Co. in Union Grove. Other steel poles were supplied by Stewart and Lloyds Ltd.

Concrete Utilities Ltd. were responsible for four concrete columns, two of the "*Arterial*" and two of the "*Boulevard*" type. The "Arterial" columns stood 14 ft. 6 in. out of the ground. They had an octagonal case of 15 in. across the flats and a pedestal of 12 in. The column was 7 in. at the base and tapered to 5 in. at the top, which ended with a cast iron spigot. A steel tube 2¾ in. in diameter is cast in the centre and extends from the top to the base of the column. The "Boulevard" columns were of similar dimensions, the pedestal, however, being fluted instead of flat. Attention is drawn to excellent reflection of light from the surfaces of these columns—a consideration of importance in promoting visibility by night.



A diffusing Lantern for Osira Lamps.



A Compact Foot-Candle Meter (G.E.C.).

Automatic control of street lamps continues to excite attention and the exhibits of this character were of exceptional interest.

As usual a very representative selection of the well-known Newbridge Gas Controllers and Electric Time Switches was shown by the Horstmann Gear Company (Bath).

A form of Gas Controller which aroused considerable interest is the *Catalytic Torch* Ignition model, which has been much improved in detail. The use of a byepass is dispensed with, ignition of the main burner being effected by means of an electrically energised catalytic filament, which ignites a pilot light turned on for a period of five minutes per day during the same time that the main gas valve is automatically opened. A further development in the field of gas lighting, was the display of a *new type of pilot head* (invented by Mr. Bloor of the York Gas Company), which is exceptionally resistant to draught, whilst being very economical. Yet another interesting item was a special controller designed for use with high pressure gas supply, for which several advantages are claimed.

The Company also showed in addition to the usual *hand-wound clocks, Synchronous Motor Drive movements* and the *Newbridge Solar Compensating Dial*, which allows any lighting and extinguishing schedule to be followed very accurately was on view.

We have already referred somewhat fully* to the very interesting and novel form of light-sensitive control which Radiovisor Parent, Ltd. exhibited, and we now illustrate above the component parts, which are of a simple character. The distinctive feature of the improved unit is the elimination of the thermionic valve. There are, moreover, no moving parts other than the switch—which normally acts only twice in the 24 hours, to bring the lights on and to switch them off.

* Illum. Eng., Sept., 1934, p. 274.

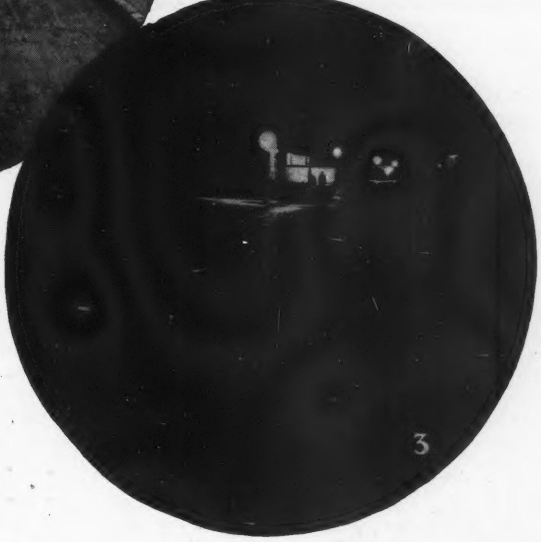
MAZDA MERCRA LIGHTING AT RUGBY

The latest and in some respects the most interesting installation of Mazda Mercra Lamps is that recently switched on at Rugby.

Three roads are lighted by the new lamps and over the whole area the illumination is remarkably brilliant and uniform. The Clifton Road photograph (No. 1) gives a very good idea of the uniformity of the illumination and affords a striking contrast to the original gas installation (No. 3).

The equipment consists of 40 BTH Diron Lanterns, each fitted with a 400 watt Mazda Mercra Lamp. The Lanterns are mounted at a height of 25 feet and are spaced 150 feet apart.

Our Illuminating Engineers will be pleased to give expert advice on any street or floodlighting problem.



1 Clifton Road—Mazda Mercra Lighting

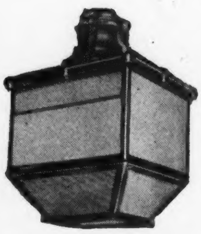
2 Clifton Road—Day View

3 Clifton Road—previous system of gas lighting

MAZDA MERCRA LAMPS

REGISTERED TRADE MARK

On each standard, at a height of 15 feet, is fitted a 150 watt Mazda Gasfilled Lamp, which is automatically switched on when the Mercra Lamp is switched out at midnight. This 150 watt lamp provides a useful stand-by in case of failure of the electric discharge lighting.



Above—BTH Diron Lantern
Left—Mazda Mercra Lamp

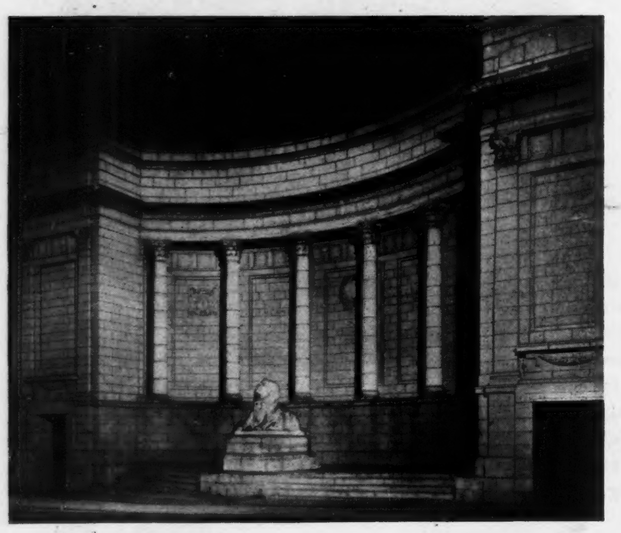
MAZDA MERCRA LAMPS & BTH LANTERNS ARE MADE IN RUGBY, ENGLAND

B T-H

M3544

THE BRITISH THOMSON-HOUSTON CO. LTD.
CROWN HOUSE, ALDWYCH, LONDON, W.C.2.

Floodlighting the War Memorial, Aberdeen



A General View of the War Memorial Floodlighted.

We present above a view of one more floodlighting installation at Aberdeen—the War Memorial, which was lighted by units supplied by the General Electric Co., Ltd. The second illustration shows a daylight view of the post carrying three lanterns; the large lantern has two glass mirrored reflectors equipped with 500-watt lamps, whilst the two smaller lanterns are furnished with 300-watt lamps.

Special lighting was also provided for the flower-beds in the Union Terrace Garden, Rosemount Viaduct, by three of the General Electric Co.'s " P. L. A." lanterns, each fitted with a 500-watt gas-filled lamp, which were attached to a high mast at the eastern extremity of the gardens.

Showing the special G.E.C. Equipment used.

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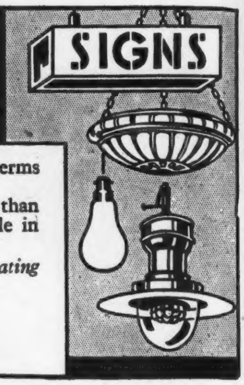

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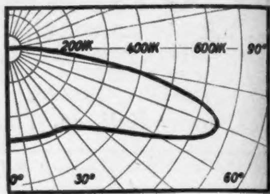
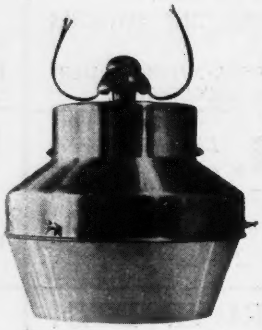
Model "B"

The "Mirrorlite" Lantern

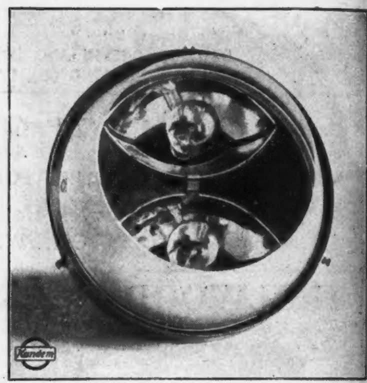
The three adjacent illustrations show the salient features of the "Mirrorlite" directional lantern, supplied by Kandem Electrical Ltd., and designed to meet the dual requirements of high efficiency and absence of glare. The lantern takes two lamps of 75-200 watts, each surrounded by a two-piece concave reflector of silvered mirror-glass. Diffusion is effected by means of a slightly opalescent glass band, fitted to the outer edge of the fitting. The main beams of light are projected up and down the street (non-axially) at about 70° to the vertical, so that the main distribution of light is removed from the normal eye-level of users of the road, and dazzle is avoided. The polar curve indicates how distribution of light is regulated to secure uniform illumination and absence of "patchy" light. The diffusing band, besides helping to eliminate glare, has the further advantage of preventing unsightly sharp shadows being cast on adjacent buildings.

Polar Curve Light Distribution of Directional "Mirrorlite" lantern.





Side view of Directional "Mirrorlite" lantern showing attachment for central spanwire suspension.



A view from below showing mirrors and diffusing band.

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